Issue : **August 2014**

Van Sangyan

Tropical Forest Research Institute
(Indian Council of Forestry Research and Education)
PO RFRC, Mandla Road, Jabalpur – 482021
Visit us at: **http://tfri.icfre.gov.in (or) http://tfri.icfre.org**
Write to us at: **vansangyan_tfri@icfre.org**

From the Editor's desk

Biofertilizers contain microorganisms that colonize the rhizosphere on application and promote growth by increasing the supply/availability of primary nutrients to the host plant, and thereby reduce the use of chemical fertilizers and pesticides. The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Therefore, they are extremely advantageous in enriching soil fertility and are more cost-effective than chemical fertilizers.

This issue of *Van Sangyan* contains an article on the prospects of biofertilizers. There are also sections on the soils of India, and how afforestation can rehabilitate barren lands, along with other useful articles. The back cover of this issue insists proper utilization of vermicompost, which is also a biofertilizer.

I hope that you would find all information in this issue relevant and valuable.

Readers of *Van Sangyan* are welcome to write to us about their views and queries on various issues in the field of forestry.

Looking forward to meet you all through forthcoming issues.

Dr. N. Roychoudhary
Chief Editor

Mango Mealybug : A Major Pest

Kritish De

West Bengal

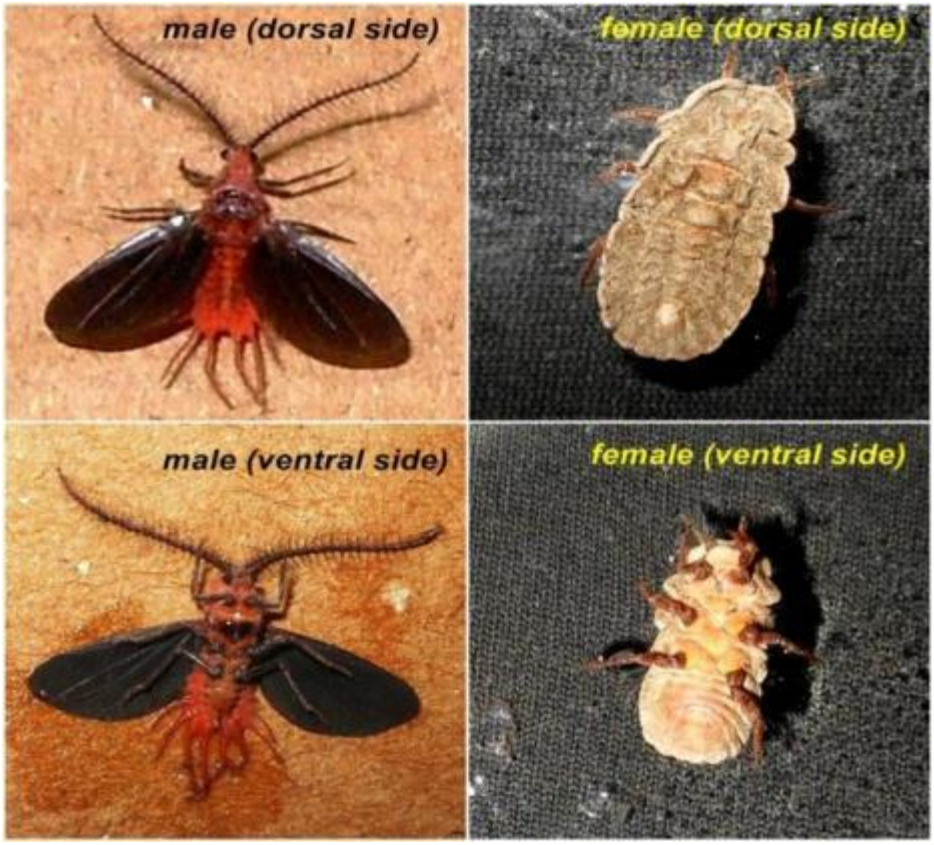
Mango (*Mangifera sp*.) is the most important commercially grown plant of India. According to National Horticulture Board, Government of India, India ranks first among world's mango producing countries accounting for about 50% of the world's mango production. Other major mango producing countries include China, Thailand, Mexico, Pakistan, Philippines, Indonesia, Brazil, Nigeria and Egypt. India's share is around 52% of world production i.e. 12 million tonnes as against world's production of 23 million tonnes (2002-03). But, this important fruit crop plant is attacked by several insect pests every year which causes economic damage. According to ICAR - National Bureau of Agriculturally Important Insects, Bangaluru there are 84 species of insects acting as pest of mango plant of which 4 insects viz. *Drosicha mangiferae* Green, *Hemaspidoproctus cinereus* (Green), *Icerya aegyptiaca* (Douglas) and *Icerya seychellarum* (Westwood) come from the family Monophlebidae (commonly called monophlebids or giant scales). Among them, last three species act as minor pest but the first one, *Drosicha mangiferae* Green is a major pest. It is commonly called mango mealybug. Though the members of the family Pseudococcidae (Hemiptera : Coccoidea) are commonly called "mealybug", however, it is also called "mango mealybug" because of its close resemblance with the mealybugs.

Distribution

Giant Scales are mostly found in tropical countries, especially mango orchard of India, Pakistan, Bangladesh and other S.E. Asian countries.

Morphological description of adult male

Body is reddish orange in color and visibly divided into head, thorax and abdomen. Head is small, bears one pair black compound eyes and one pair antennae. Antennae are as long as the length of the body, black in color, segmented. Each segment of antennae bears one pair lateral bristle. Thorax has two black spots, one on dorsal side and another on ventral side. Thorax bears three pairs of externally jointed legs and one pair black colored wings. Coastal margin of wing is strongly developed. Median – flexion line and claval furrow of wing are also well developed. Abdomen has four pair of fleshy caudal tassels. Penis sheath strongly tapering, the apex produced into a slender, almost cylindrical style with rounded tip.



Morphological description of adult female

Body is elongated oval, body length (10 mm or more) is twice than the width (5 mm or more), dorsal side somewhat concave but ventral side is flattened. Body is covered by white waxy coating. Body is divided into head, thorax and abdomen but these parts are fused so that it is tough to distinguish. One pair segmented, dark brown colored antennae are present. Wings are absent. Three pairs of externally jointed dark brown colored legs are present. Thoracic spiracles often with pores, concentrated near entrance of atrium. Well developed anal tube present, with a simple sclerotized ring or band of pores at inner end. Abdominal spiracles present and simple, without a pore collar (it is the microscopic key character of family – Monophlebidae to distinguish it from family - Pseudococcidae). Mature female often with flutted ovisac or with a marsupium (it is the field key character of family – Monophlebidae to distinguish it from family - Pseudococcidae).

Life cycle

Drosicha mangiferae Green has 1 generation each year. Female lay eggs between April to May. Purple-colored eggs are laid in egg sacs comprising mass of wax threads, in the loose soil around (within 2 – 3 m radius) the infested trees. Initially, maximum eggs are laid daily i.e. 56 per day and at the end minimum eggs are laid i.e. 1 per day. The egg laying

ranges from 221 to 361 per female in 9 to 16 days. The eggs hatch in the month of December – January and 1st instar nymph emerge and move upward the plant with an average speed of 12.4 cm/minute. 1st instar nymph can live without food for 5 to 19 days and this stage lasts for 45 to 71 days in both male and female after which they moult to form 2nd instar nymph. The 2nd instar nymph moves upward the plant with an average speed of 17.3 cm/minute. The 2nd instar nymph can live without food for 3 to 23 days. The 2nd instar stage lasts for 18 to 38 days in both male and female. After that, they moult to form 3rd instar nymph. The 3rd instar moves upward the plant with an average speed of 37.1 cm/minute. The 3rd instar nymph can live without food for 3 to 23 days. The 3rd instar stage lasts for 15 to 26 days for female and 9 to 15 days for male. Then, the female moults to form adult whereas, the male goes to pupa stage. The pupa stage lasts for 9 to 15 days. After that, the adult male appears. During the month of March – April, both adult male and female are present. Life span of adult male is about one week, but life span of adult female is about one month. During this time, they perform copulation. The males fly where the flightless females are present and mating time varies from 6 to 20 minute.

Damage

Only nymph and adult female cause damage to the plants, but adult male causes no damage. The nymphs and adult female suck sap from inflorescence, tender leaves, shoots and fruit peduncles. As a result, the affected inflorescences are shriveled and get dried. Rigorous infestation affects the fruit set and causes fruit drop. They exude honey dew over the leaves, on which sooty mould is developed which causes damage. Chief host of this insect is *Mangifera sp*. (Anacardiaceae) i.e. mango plant. Though it is a major pest of mango plant, it also causes damage to cacao, tamarind, citrus etc.

Female nymph after moulting

Control Measures

It can be effectively controlled by ploughing the soil (upper 6") during May – June as female lays eggs in the soil. Mixing methyl parathion dust 2% @ 250gm/tree in the basal region after ploughing gives good result. Spraying of 0.20% carbaryl or 0.040% monocrotophos also kills nymps on shoots. Research shows that Profenofos (Curacron® 50

EC) at 800ml/100L water and Methomyl (Lannate® 40 SP) at 250gm/100L water is effective against first and second instar nymph.

Eco-friendly and popular method to minimize the damage to the tree is the use of physical barriers against nymphs to crawl up the stem. During the month of November to February, banding of the basal trunk of the tree with 15 – 20 cm wide slippery alkathene sheet prevents newly hatched nymphs to climb the tree. Making sticky bands at 30 – 40 cm above the ground level with rosin and castor oil or grease or coal tar also prevent the nymphs to climb the tree.

Research shows that the fungus *Beauveria bassiana* (Bals.-Criv.) Vuill. can effectively reduces first instar nymph of this insect. It is reported that three species of jumping spiders (Salticidae) - *Lyssomanes sikkimensis* Tikader 1967; *Myrmarachne bengalensis* Tikader 1973; and *Zygoballus indica* and one species of wolf spider (Lycosidae) - *Lycosa mackenziei* Gravely, 1924 predate on this insect. Thus, these spiders can also be used for biological control of giant scales.

Note : Though *Drosicha mangiferae* Green is commonly called mango mealybug, however, the *Rastrococcus mangiferae* (Green) (Coccoidea: Pseudococcidae), *Rastrococcus invadens* (Green) (Coccoidea: Pseudococcidae) are also commonly called mango mealybug.

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Bamboo and Rural Livelihood

Swaran Lata, Dr P. K. Khatri and Sanjay Singh

Tropical Forest Research Institute, Jabalpur

Bamboo is one of the fastest growing ancient woody grasses and known as green gold and poor man's timber. Another peculiarity of bamboo is that most species flower very infrequently, with intervals as long as 60 to 120 years. These species exhibit 'mass flowering' where all plants in the population flower at the same time. Bamboo is an important forest resource for the rural communities both for farming activities as well as a source of food and cash income. It belongs to family Gramineae and subfamily Bambusoideae and is found in forest and non forest areas. It is closely associated with indigeneous culture and used for house construction, bamboo ply, agricultural implements, handicraft, irrigation, brooms, umbrellas, medicine, food, fuel, fodder and papers since ancient time. Today it has much potential for income generation, employment generation and poverty alleviation by improving the economic condition of bamboo-dependent people. It grows everywhere in the world except in extremely cold climates.

It is thought to have originated in China, where the first use of bamboo to make every day items was recorded. With the growing demand of timber it is substitute of timber due to renewable property. Particular environmental conditions like higher temperature, air humidity, availability of water promotes clum growth. It is harvested for construction purpose when clums reaches greatest strength and sugar content in sap is lowest. Higher sugar content in sap at the time of harvestation promotes pest infestation rate. Major bamboo research began after 1920 when history of plant was studied. There are 1200 species belonging to 90 genera throughout the world. In India there are 125 species of bamboos belonging to 23 genera. India is second richest country in the world after China in terms of Bamboo genetic resources. It occupies an area of 14 million hectare land in India. It is found in all parts of the country from tropical to temperate regions except Kashmir region where bamboo does not occur naturally. More than 50 % of bamboo species occur in Eastern India.

Madhya Pradesh ranks first in its forest cover and forestry plays a very important role in improving the economy of the state. Bastar, Balaghat, Hoshangabad, Mandla, Raipur, Shahdol, Seoni, Jabalpur etc are the bamboo rich regions in Madhya Pradesh. *Dendrocalamus strictus, Bambusa vulgaris, Bambusa bambos, Gigantochloa rostrata, Schizostachyum pergracila* are the

main species of bamboo growing in Madhya Pradesh of which *Dendrocalamus strictus* is most important species and grows throughout the state. Bamboo, which is an important forest produce, has high significance in socio economic life of the rural people. In Madhya Pradesh, two communities *basod* and *nistari* are the main consumers of bamboo. Basods are the people belonging to community of bamboo craftsmen who are traditionally dependent on bamboo for their livelihood. The nistaris use bamboo for house repair and crop harvesting and other domestic uses.

The importance of forest in an area is reflected by the multiple uses, such as source for fuel wood, tools and implements, timber, fodder, leaf litter and other NTFPs. Bamboo is one of the NTFPs which is used in improvement of rural livelihood of the people in different ways:

Bioenergy

Through pyrolysis, bamboo can be converted into three valuable products: bamboo charcoal, oil and gas. Bamboo charcoal is traditionally used as a substitute for wood charcoal or mineral coal. It can serve as a fuel, absorbent and conductor. In some areas the situation is so bad that poor villagers need to purchase fuel wood or walk miles to collect the fuel wood; hence bamboo plantation in waste land are excellent alternate of fuel wood. Utilization of this renewable fuel can save vast natural forest resources and fossil fuels such as coal, oil and gas. This would allow retention of carbon already sequestered in forests and in fossil fuels. It can produce 30% more oxygen than a hard wood forest of comparable size. Biomass based power generation has huge potential to electrify the non-electrified villages and biomass gasification technology can also create employment in rural areas.

Pulp, Paper and Clothing

It is used in pulp, paper and cloth making. Bamboo paper has practically the same quality as paper made from wood. Paper made from wood may deteriorate over time but paper made from bamboo does not deteriorate. Because of its non irritant quality it is used in baby cloths.

Furniture and Flooring

Bamboo is used for making furniture from ancient times. Today Bamboo flooring is preferred over wooden floors due to its smoothness, brightness, stability, high resistance, insulation qualities and flexibility.

Food and beverage

Young bamboo shoots are edible in many parts of the world. Bamboo vinegar is extracted while making charcoal and is used for hundreds of treatments in almost all fields. This liquid contains 400 different chemical compounds and can be applied for many purposes including cosmetics, insecticides, deodorants, food processing and agriculture.

Role of Bamboo products in rural livelihood




Reforestation

It should be selected as an alternative to other trees not only for reforestation but also for afforestation because of fastest growing rate, easy propagation, tensile strength and renewable property. It protects steep slopes, soils, water ways and controls soil erosion.

Bamboo has played and is still playing an important role in improving the livelihoods of rural people. The farmers produce a wide range of bamboo products that are marketed individually at present. The unavailability of transportation, low product prices and varying product quality are some of the main concerns of the bamboo handicraft producers. Therefore, possibilities need to be explored for forming bamboo handicraft production and marketing by the interested farmers. The growing urban population and their increased demand for bamboo products are new oppurtunities to bamboo dependent people. This will help to improve income as well as employment opportunities to the rural people. With rapid increase in demand due to rising population have caused depletion of bamboo resource in certain areas are also a growing concern among the users. In depth study of bamboo resource and factors responsible for its depletion is needed for future management of bamboo resources. Central India has many types of bamboo and it has potential of providing self employment and income by bamboo based products. Hence there is need to promote the utilization of bamboo based products.

Hybrid seed production in cotton

Naseer Mohammad

Genetics & Plant Propagation Division, Tropical Forest Research Institute, Jabalpur

Cotton is a major fibre crop of global importance and has high commercial value. Four out of 50 recognized cotton species in the world are cultivated. Two of them [*Gossypium arboreum* (2n = 26) and *Gossypium herbaceum* (2n = 26)] are diploid, and remaining two [*Gossypium hirsutum* (2n = 52) *Gossypium barbadense* (2n = 52)] are tetraploids. More than 80 per cent of the world's area is covered by *Gossypium hirsutum* and *Gossypium barbadense*; however diploid cottons are also cultivated in Asia and Middle East. India is the only country where all the cultivated species and some of their hybrid combinations are commercially grown**.**

Cotton and cotton textiles constitute a major share of agricultural export. In sixties, the production of cotton was about 5 million bales, mostly of short and medium staple cotton. With the advent of hybrid cottons in the seventies, a sea change was brought in cotton scenario both qualitatively and quantitatively. Today, 23.15 million bales of cotton consisting of short, medium, long and extra long staple are produced annually.

HISTORICAL PERSPECTIVE

The phenomenon of **heterosis or hybrid vigour** is known in cotton since 1894 when Mell first reported an increase in agronomic and fibre properties through cotton hybrids. Thereafter, Balls reported hybrid vigour in the inter-specific crosses between upland and Egyptian cottons. Since then, a number of workers in India, USA and elsewhere recorded the heterosis for various traits both in the intra-hirsutum and inter-specific (*Gossypium hirsutum* x *Gossypium barbadense*; *Gossypium herbaceum* x *Gossypium arboreum*) crosses. Several workers reported higher heterosis in case of inter-specific (*G. hirsutum* x *G. barbadense*) hybrids compared to the intra-specific (*G.hirsutum x G. hirsutum*) crosses. However this heterosis could not be commercially exploited due to the tedious task of hand emasculation and pollination required for the hybrid seed production, especially in the absence of male sterility systems in cotton during those days.

With an objective to achieve self sufficiency in cotton, especially for the long and extra long staple cottons, serious attempts to develop hybrid cottons combining both the yield and quality attributes began in India in the late thirties mainly at the Cotton Research Station, Surat in Gujarat State of India under the leadership of late Dr. C. T. Patel**.** Their strenuous efforts to commercially exploit heterosis bore fruits during late sixties

when **Hybrid-4**, a cross between **G 67**, a commercial cultivar of Gujarat and **Nectariless** an exotic accession from the USA, was developed and released for commercial cultivation.

HYBRID SEED PRODUCTION

In cotton, there are two methods of hybrid seed production, viz., Conventional method and Male sterility based method.

CONVENTIONAL METHOD

- Breeder or certified seed of male and female parents is used for the production of hybrid seed.
- Land requirement: must be free from volunteer plants of cotton.
- Isolation requirements: isolation of 50 meters for certified seed production from other varieties of same or other species is necessary for certification.
- The female and male parents are planted in the same field in separate plots in 4: 1 or 5: 1 ratio.
- Sowing of parental material is done in such a way that there should be nicking in the flowering time of both the parents.
- The female and male parents are planted at wider spacing for easy movement during crossing.
- Spacing: Between rows - 150cm; Between plants - female -120 cm, Male - 60 cm.
- Seed rate: Female – 3.75 kg/ha, Male - 2.75 kg/ha
- The off type plants are rogued out before initiation of crossing programme. Higher doses of fertilizer and recommended plant protection measures are used to raise healthy crop to get continuous flush of flowers

Crossing techniques

In cotton, hybrid seed production is carried out by artificial crossing. The crossing refers to hand pollination. The crossing technique consists of three main steps, viz.,

1. **Selection of Bud**

The selection of flower bud for emasculation is an important step in hybrid seed production. The crossing work is initiated after one week of flower initiation. The flower buds of proper stage (buds which are likely to open the next day) are selected for emasculation. Such buds have generally cream colour and are well developed.

2. **Emasculation**

- The process of removal of anthers from the selected flower bud is referred to as emasculation.
- Anthers of selected buds are gently removed with the help of nail of the thumb as suggested by Doak (1934).
- The emasculated buds are covered with tissue paper bag of red colour to prevent natural out-crossing.

- The best time for emasculation is 3-6 PM. Some people use straw tube to cover the ovary of emasculated bud. Emasculation is not required when hybrid seed is produced using male sterility.

3. **Pollination**

Emasculated buds are pollinated the next morning with the pollen of male parent. Best time for pollination is 8-11 AM, when the stigma receptivity is max. Generally, 4-5 buds are pollinated by one flower of male parent. After pollination, the red tissue paper bags are replaced by white tissue paper bags. For identification, a label or thread is also tied on the pedicel of crossed bud for identification of crossed bolls.

Precautions

- After pollination, keep suitable identity by tying cotton thread for easy picking and avoiding mixing.
- Remove all unemasculated and unused flowers (other than crossed ones) daily so as to retain only genuine crossed flowers (bolls) on the female parent. Destroy leftover collected male flowers after use.
- Remove off-type plants, if any, in female and male parents before crossing is commenced.

MALE STERILITY BASED METHOD

Two types of male sterility systems are mainly used in cotton, viz., Genetic male sterility, and Cytoplasmic genetic male sterility.

Genetic Male Sterility

In cotton, Gregg male sterility is the only source utilized in India, Pakistan and USA. This male sterility is governed by two recessive genes (*ms5* and *ms6*). The male sterility is transferred to any female parent through backcross technique. Maintenance of GMS lines involves sibmating between male sterile plants and heterozygous male fertile plants. Cross of this male fertile genotype with sterile line will always produce male sterile and male fertile plants in 1 : 1 ratio. Fertile plants are identified after flowerings are removed. The male sterile plants are pollinated with the pollen of male parent to get hybrid seed. In case of male sterile parent, 3-4 seeds should be sown per hill because 50% of the population (male fertile) is removed when flowering starts.

Cytoplasmic Genetic Male Sterility

In cotton, mostly *G.harknessii* (D_2 CMS) cytoplasm is used as a source of cytoplasmic genetic male sterility (*G. trilobum* D_8 CMS and *G. aridum* D_4 CMS also induce stable male sterility for practical hybrid seed production). The restoration in D_2 CMS involves monogenic dominant action with one enhancer gene. The male sterile parent (female) is pollinated with the pollen of restorer (male) parent. After pollination,

flowers are covered with tissue paper bags to avoid natural out crossing with other plants.

Male sterility in diploids

There are at present two sources of GMS

1. **Hisar source**: The recessive GMS in *G. arboreum* cotton variety, DS 5 (GMS-1) have white flowers with petal spot. The GMS-1 was isolated as a spontaneous mutation.
2. **Akola Source**: The GMS line GAK-423A is developed by transferring the genome of *G. arboreum* (AKH-4) in to *G. anomalum* cytoplasm (Meshram and Wadodkar, 1992). This source has yellow, larger flowers than DS 5 GMS and possesses dark petal spot.

India is the first country to release a GMS based hybrid (AHH-1) in diploids.

Chemically Induced Male Sterility

Chemicals FW 450 (Sodium a-dichloro-iso-butyrate) and TD 1123 (Chemical constituent not known) have been demonstrated to posses male gametocide action. However, their commercial viability has not been established so far.

Topping: Top and side shoots may be nipped suitably to control optimum growth and better boll development. Inadequate or excessive irrigation should be avoided. Stop irrigation a week before last picking.

Picking: Pick completely opened crossed boll (kapas) as and when ready in baskets and sort out. Any bolls without thread be kept aside

and only genuine crossed bolls are kept separately for use. Remove hard locks, stained kapas etc. keep good crossed boll kapas for processing. Dry well-cleaned kapas in shade after each picking and store in a good place picking-wise lots. Slow ginning is to be practised to recover good quality seed and without cutting the seed. After ginning, the seeds may be kept well spread, air dried, without heaping.

Acid delinting

100ml of commercial sulphuric acid/kg seed treated for 2-3 minutes and washed thoroughly with lime water/fresh water till free of acid.

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पड़ती भूमि पर वनों का पुनर्वासन

डॉ. ए. के. भौमिक

उष्णकटिबंधीय वन अनुसंधान संस्थान, जबलपुर

पड़ती भूमि पर वनों को विकसित करना वनीकरण कहलाता है। इस प्रकार से विकसित वन को कृत्रिम वन कहते है। ऐसी भूमि जो अनेक कारण से अधोगति को प्राप्त हो चुकी है, तथा इसका वर्तमान में उचित उपयोग नहीं हो पा रहा है, पड़ती भूमि कहलाती है। अप्रत्यक्ष रूप से देखा जाय तो बड़ती हुई मानव तथा पशु संख्या ही प्रमुख कारणों है जा जलाऊ लकड़ी तथा पशु चारा की पूर्ति के लिए वनों के अत्याधिक दोहन के लिए उत्तरदायी है, जिससे भूमि क्षरण होकर पड़ती भूमि का निर्माण करती है। वनों के अन्धाधुन्ध कटाई पर रोक लगाकर तथा नयें वनों का रोपण करके पड़ती भूमि को सुधारा जा सकता है।

पृथ्वी पर मानव के अस्तित्व को बनाए रखने के लिए कुल भुभाग का 33% भाग वनों से आच्छादित होना चाहिए। अतः आवश्यकताओं की पूर्ति के लिए भूमि को सर्वोत्तम स्थिति में बनाए रखना अति आवश्यक है। भारत के कुल भौगोलिक क्षेत्रफल का लगभग 50% भाग अधोगति को प्राप्त हो चुका है। जंगलों के क्रूरतापूर्ण कटाई से बाढ़ आना, अतिवृष्टि, अनावृष्टि (सूखा पड़ना) व अनिश्चित वर्षा के दुष्परिणाम परिलक्षित हो रहे है। इसके विपरीत प्रभाव भूमि के उपजाऊपन पर भी पड़ रहा है और भूमि की उर्वरा शक्ति भी कम हो रही है।

आज देश में पड़ती भूमि का क्षेत्रफल करीब 17.5 करोड़ हेक्टर है। हालाकि पड़ती भूमि विकास उत्थान समिति ने 12.0 करोड़ हेक्टर पड़ती भूमि दर्शायी है। जिसमें 3.6 करोड़ हेक्टर वन क्षेत्र का तथा शेष 9.3 करोड़ हेक्टर अन्य क्षेत्र में है। मानव तथा वृक्षों का संबंध सनातन है। अस्तित्व एवं विकास के लिए वे एक दूसरे के परिपूरक है।

देश में कुल पड़ती भूमियों में मध्यप्रदेश की हिस्सेदारी काफी अधिक है। जिसमें ज़्यादातर क्षेत्र गलीयुक्त बीहड़ भूमि, खाली पड़ी हुई वन भूमि व पथरीली भूमि का है। इन सभी भूमियों के सुधार के लिए उचित वैज्ञानिक प्रबंधन की आवश्यकता है। सामान्यतः पड़ती भूमियों के अन्तर्गत उन भूमियों का माना जाता है, जो कि कृषि के लिए अनुपयोगी है। परन्तु सही अर्थो में ऐसी सभी खाली पड़ी भूमियॉ जो ध्यान न देने के कारण रिक्त या अनुपयोगी रह गई हो, अथवा चराई, भूमि क्षदण के कारण अनुपजाऊ व अलाभकारी हो गई हो, पड़ती भूमि के अंतर्गत आती है।

वानिकी की उपयोगिता एवं महत्व

1. स्थानीय पारिस्थितिकी संतुलन को बनाए रखना।
2. ग्रामीन तथा आदिवासियों को अधिक से अधिक रोजगार
3. बड़ती हुई आबादी एवं उसी अनुपात में बड़ती हुई मॉग की पूर्ति हेतु वनों का अधिकता उपयोग
4. स्थानीय आवश्यकताओं की पूर्ति हेतु वनों का अंधाधुंध कटाई से बचाव
5. पड़ती भूमि के स्तर में सुधार
6. भूमि की उर्वराशक्ति एवं जल–संरक्षण में सहायक
7. भूमि कटाव रोकने एवं जल संरक्षण में सहायक
8. पोषक तत्वों का संरक्षण एवं पुनरचक्रण

पड़त भूमि पर पौधों की त्वरित वृद्धि के लिए उपयुक्त प्रजातियॉ

पड़ती भूमि तथा अपशिष्ट भूमि का पूर्नस्थापन का तकनीकी ज्ञान विकसित किया गया है। इस हेतु विभिन्न परिक्षेत्रों में विभिन्न प्रकार में प्रायोगिक कार्य किया गया, तथा विभिन्न प्रजातियों का चयन एवं उसकी उपयुक्तता को इसी अपेक्षित एवं अपशिष्ट/ पड़त भूमि में कार्यावित किया गया। संदर्भित प्रयोगो के आधार पर निम्न निष्कर्ष पाए गये है।

1. कंकालित मृदा : सफेद सिरस, सिस, आस्ट्रेलियन बबूल, खमेर, केसिया, नीलगिरी प्रजाति

2. लवणीय मृदा : खैर, बबूल, महानीम, सफेद सिरस, नीलगिरी प्रजाति, जामून, अर्जून, बेर, बहड़ा
3. भाटा भूमि : खमेर, ऑवला, अमलताश, शीशम, सफेद सिरस, कालासिरस, बबूल, सुबबूल, सीसू
4. भूमि क्षरण रोकने के लिए वृक्ष प्रजातियॉ : बेर, शीशम बॉस, सिरिस, खेर, नीम
5. भूमि को उपजाऊ बनाने के लिए : सुबबुल, बबूल, अशस्त, शीशू, चकोड़ा
6. जलाऊ लकड़ी के लिए : बबूल, खेर, करंज, घावड़ा, जामुन, सुबबुल
7. गृह निर्माण तथा बल्लियॉ हेतु : पॉपलर, यूकेलिप्टस, बॉस
8. पशुचारा के लिए : सुबबुल, बबूल, सिरिस, बेर, सिश्सू, खैर
9. फलों हेतु : आम, जामुन, महुॅआ, कैथा, ईमली, बेर, भिलवा, तेन्दू, गुलर
10. औषधीय वृक्ष प्रजातियॉ : ऑवला, हर्रा, नीम, बेल, बहेड़ा
11. शीघ्र वृद्धि होने वाले वृक्ष : विलायती बबूल, शीशम, अगस्त, सिरस, बबूल, खम्हार
12. जलमग्न क्षेत्रों हेतु : यूकेलिप्टस, करंज, सिश्सू, बबूल, अर्जून, सफेदर सिरस, काला सिरस
13. भूमि कटाव रोकने हेतु : बॉस, लेन्टाना प्रजाति, प्रोसोपिस
14. चट्टानी, बंजर एवं पथरीली भूमि हेतु : बेल, जंगलजलेबी, बेर, पलाश, कुल्लु
15. कोयला खान क्षेत्र : विलायती इमली, सिमेरूबे ग्लोका, अकेशिया मेनजियम, कैसिया साइमिया, सिश्यू, खमेर
16. लौह अयस्क खदान : सुबबुल, नीलगिरी प्रजाति, सफेद सिरस, खमेर, सिश्यू, ऑवला
17. तॉबा खदान क्षेत्र : खमेर, नीलगिरी प्रजाति, अकेसिया लेन्टिकुलेरिस, सफेद सिरस
18. चूना खदान क्षेत्र : बबूल, सिश्यू, सुबबुल, खेर, सफेद सिरस, रतनजोत, नीलगिरी प्रजाति, खमेर, नीम

आवश्यक/उपयोगी जानकारियॉ :

- मल्चिंग पौधों के वृद्धि एवं आर्द्रता हानि को बचाए रखने के लिए विभिन्न मल्चेस का प्रयोगों द्वारा अध्ययन किया गया जिसमें घास का महत्व सबसे उपयुक्त पाया गया।
- वर्मीकम्पोस्ट एवं कम्पोस्ट खाद का मिश्रण (प्रत्येक 2 कि.ग्र.), जलशक्ति 10 ग्रा. प्रति गड्ढे (45 से.मी. x 45 से.मी. x 45 से.मी.) के साथ (कार्बनिक आर्द्रता को बॉधने के लिए) तथा घास मल्च प्रयोग करने पर पौधों की जैव मात्रा वृद्धि एवं पौधों की ऊॅचाई तथा मोटाई वृद्धि में बहुत लाभदायक पाया गया।
- पड़ती भूमि पर 40 ग्राम यूरिया और 40 सुपर फास्फेट प्रति पौधे के दर से सयुक्त प्रयोग लाभदायक है।
- पड़ती भूमि पर नाली खोदकर 20 ग्राम वैम (VAM) और रायजोबियम (सूक्ष्मजीव) प्रति पौधे के हिसाब से सफेद सिरस तथा काला सिरस पर प्रयोग करने पर पौधो की लम्बाई, मोटाई के साथ साथ मृदा में कार्बानिक पदार्थ एवं उनके जल अवशोषण क्षमता में अधिकता पाई में कार्बनिक पदार्थ एवं उनके जल अवशोषण क्षमता में अधिकता पाई गयी।
- पड़ती भूमि पर 2 मीटर x 2 मीटर तथा 4 मीटर x 4 मीटर की दूरी पर सिश्यू के पौधे लगाकर एक प्रयोगत्मक अध्ययन उष्ण कटिबंधीय वन अनुसंधान संस्थान के प्रागण में किया गया, परिणाम दर्शाता है कि 4 मीटर x 4 मीटर की दूरी पर अधिक जीवित पौधे पाये गये इसके साथ ही साथ उनके बीच के अन्तराल में सतही पौधों की प्रजाति तथा उनके जैव मात्रा भी 2 मीटर x 2 मीटर की दूरी की तुलना में अधिक पायी गयी।

खनिज खदानों का पारिस्थितिकीय पुनर्वास

1. खदान क्षेत्र की भूमि का तकनीकी पद्धतियों द्वारा विकास कराना।

2. खदान क्षेत्र में भूमि के विकास की विधियॉ :–

- अभियांत्रिकीय विधि
- जैविक विधि

3. निम्न खदानों में प्रायोगिक कार्य किया गया :–

कोयला खदान, लोहा खदान, तांबा खदान, चूना खदान, बॉक्साइट खदान

4. खदान क्षेत्र में निम्नलिखित पैमानों के आधार पर वृक्षारोपण हेतु प्रजातियों का चयन।

- प्रभावित क्षेत्र में विकसित होने वाली प्रजातियॉ।
- प्रभावित भूमि में नाइट्रोजन स्थिरीकरण वाली प्रजातियॉ।
- स्थानीय लोगों हेतू, ईंधन, चारा एवं रेशें उप्पन्न करने वाली प्रजातियॉ।
- पक्षीयों तितलियों एवं अन्य वन्य प्राणीयों को आकर्षित करने वाली प्रजातियॉ।
- उन्नत एवं स्वस्थ वृक्षों द्वारा बीजों का चयन।

कोयला खदानों की भूमि का विकास

अध्ययन क्षेत्र

- जेवरा एवं विश्रामपुर (छ.ग.)
- सिंगरौली (म.प्र.)
- तालचेर (उड़ीसा)

उचित प्रजातियॉ

विलायती इमली (जंगल जलेबी), सिमेरूबा ग्लाका, अकेसिया मैन्जियम, केसिया सेमिया, सिसू , खमेर

प्रयोगात्मक परिणाम

- अच्छे परिणाम हेतु प्रथम वर्ष 100 ग्राम यूरिया 25 ग्राम एस.एस.पी. एवं 25 ग्राम पोटाश म्यूरेट प्रति पौधा डाला जाये।
- वृक्षों की अच्छी उपज एवं वृद्धि हेतु खदान की मिट्टी एवं कंपोस्ट का 1:2 का मिश्रण गड्ढो में भरा जायें।
- तापीय दबाव को कम करने के लिये अपघटित मृदा सड़ी–गली पत्तियों जिससे मृदा में ह्यूमस की अधिकता को बढ़ाना।
- खदानों के आसपास की पड़त भूमि में तीन ट।ड कवकों की प्रजातियों की पहचान की गई, जिनका वृद्धि एवं जैवभार को प्रभावित करने से संबंध है।
- उपरोक्त वर्णित पौधों की प्रजातियों द्वारा नाइट्रोजन स्थिरिकरण अधिकतम पाया गया।

लौह अयस्क खदानों की भूमि का विकास अध्ययन क्षेत्र

- दल्ली राजहरा (छ.ग.)
- महामाया खदान (छ.ग.)

उचित प्रजातियॉ

सुबबूल, नीलगिरी प्रजाति, सफेद सिरस, खमेर, सिसू , ऑवला

प्रयोगात्मक परिणाम

- पौधरोपण में खदान की मिट्टी एवं कम्पोस्ट खाद को 1:2 में मिलाकर गड्ढो भरे गये।
- पत्थर/बजरी की अपेक्षा भूसा तथा सड़ी–गली पत्तियों की मिट्टी में अच्छे परिणाम पाये गये।
- अधिकतम जैवभार को बढ़ाने के लिये 100 पी.पी.एम. नाइट्रोजन और 25 पी.पी.एम. फास्फोरस डाला गया।

तांबा खदान क्षेत्र की भूमि का विकास प्रयोगात्मक क्षेत्र

- मलाजखण्ड (म.प्र.)

रोपण हेतु उचित प्रजातियॉ

खमेर, नीलगिरी प्रजातियॉ (ग्रेंडिस, कमाल्डयुलेन्सेसए टेरिटोकॉर्निस), अकेसिया वेन्टिकुलेरिस, सफेद सिरस

परिणाम : पौधों में अच्छी वृद्धि हेतु नेट्रिन, बैक्टिन और फॉसफीन की प्रति पौधा 1 ग्रा./कि.ग्रा. का उपयोग किया गया।

चूना खदानों की भूमि का विकास अध्ययन क्षेत्र

- कुटेश्वर खदान, बारही, कटनी (म.प्र.)

रोपण हेतु उचित प्रजातियॉ

बबूल, सिसू, सुबबूल, खैर, सफेद सिरस, रतन जोत, नीलगिरी प्रजाति (हाइब्रिड), खमेर, साइमारूबा ग्लोका, नीम

बॉक्साइट खदान की भूमि का विकास

अध्ययन क्षेत्र

- अमरकंटक (म.प्र.)

रोपण हेतु उचित प्रजातियॉ

ऑस्ट्रेलियन बबूल, नीलगिरी प्रजाति (कमाल्डुलेन्सिस), वाटल ब्रुश, चीर पाइन

परती भूमि में वानिकी की संभावनाए

1. सर्वप्रथम पड़ती भूमि जहॉ वृक्ष लगवाना हो वहॉ झाड़ियों, घास इत्यादि को साफ कर देना चाहिए।
2. पौधे लगाने के लिए गड्ढे, अप्रेल, मई, में खोद लेना चाहिए। गड्ढे को मिट्टी की बाहर रहने देना चाहिए, जिससे तेज धूप में दीमक तथा अन्य हानिकारक जीव नष्ट हो जाय।
3. दीमक के प्रकोप से बचने के लिए 15 – 20 ग्राम एल्ड्रेक्स पाउडर का छिड़काव (प्रति 10) गड्ढे के भीतर करना चाहिए।
4. पौधे लगाने का सबसे अच्छा समय जुलाई, अगस्त होता है।
5. गड्ढों का भराव उसमें से निकली हुई मिट्टी तथा गोबर की पकी हुइ खाद का मिश्रण (1:1) से करना चाहिए।
6. एक गड्ढे में एक ही पौधा लगाना चाहिए।
7. उचित गहराई पर पौधो को लगाना चाहिए तथा पौधे की मुख्य जड़ को सीधा रखना चाहिए।
8. पौधे लगाने के बाद मिट्टी को पौधे के चारो तरफ अच्छी तरह दबा देना चाहिये।
9. पौधा लगाने के तुरन्त पश्चात् पानी डालना चाहिए या जब हल्की बारिश हो रही हो उस वक्त रोपण करना चाहिए।
10. यथा सम्भव पौधे सांयकाल लगाये (यदि वर्षा न हो रही हो तो)।
11. चूकि पड़ती भूमि में आवश्यक तत्वों की कमी होती है अतः पौधा लग जाने के पश्चात् 40 ग्राम यूरिया तथा 40 ग्राम सिंगल सुपर फास्फेट प्रति गड्ढे के हिसाव से डालना चाहिये। साथ ही यह ध्यान रखना चाहिए कि यूरिया का छिड़काव 20 ग्राम तथा 20 ग्राम द्वितीय माह के अन्तराल में डालना चाहिये। उपरोक्त दोनों ही रसायनिक खाद छिड़काव के तुरन्त बाद झारे की मदद से पानी अवश्य देना चाहिए।
12. गर्मियों में सुबह या शाम के समय ही पानी देना चाहिए।
13. कम नमी वाले क्षेत्रों में इस प्रकार की व्यवस्था करें कि वर्षा का जल पौधे की तली में या आसपास संरक्षित हो परन्तु किसी भी स्थिति में वर्षा का जल पौधे की तली में या आसपास संरक्षित हो। परन्तु किसी भी स्थिति में वर्षा जल भराव तने की स्पर्श न करें। अन्यथा पौधा रोगग्रस्त हो सकता है।
14. गर्मी के मौसम में सुखे पत्रों का मल्च पौधे के चारों ओर डालकर करना चाहिए जो न केवल मिट्टी की आर्द्रता को लम्बे समय तक बनाये रखेगा अपितु इन पत्तियों के क्षरण के पश्चात् मृद ामें पोषक तत्वों की भी वृद्धि करेगा।
15. एक दो साल तक खरपतवार पर नियंत्रण अवश्य करें।
16. छोटे पौधों की जानवरों से सुरक्षा अति आवश्यक है। अतः पौधों की रक्षा सुनिश्चित करें।

विभिन्न पड़त भूमि के लिए उपयुक्त वृक्ष प्रजातियॉ :–

1. कम गहराई तथा चट्टानीय भूमि (Degraded/skeletal/lateritic/eroded soils)

नीम *(Azadirachta indica),* ऑवला *(Emblica officinalis),* बबूल *(Acacia nilotica),* बेल *(Aegle marmelos),* खैर *(Acacia catechu),* सलई *(Boswellia*

serrata), बॉस *(Dendrocalamus strictus),* सुबबुल *(Sesbania sesban),* ऑस्ट्रेलियन बबूल *(Acacia auriculiformis),* अंजन *(Hardwickia binata)*

2. रेतीली भूमि (Sandy soil)

जामुन *(Syzygium cumini),* खैर *(Acacia catechu),* खमेर *(Gmelina arborea),* ईमली *(Tamarindis indica),* नीलगिरी प्रजाति *(Eucalyptus tereticornis),* सलई *(Boswellia serrata),* बेल *(Aegle marmelos)*

3. क्षारीय भूमि (Alkaline soil)

ऑवला *(Emblica officinalis),* बबूल *(Acacia auriculiformis),* करंज *(Pongamia pinnata),* सफेद शिरस *(Albizia procera),* अर्जून *(Terminalia arjuna),* शीशम *(Dalbergia sissoo)*

4. जल प्लावित भूमि (Water logged soil)

नीलगिरी *(Eucalyptus tereticornis),* करंज *(Pongamia pinnata),* अर्जून *(Terminalia arjuna),* सलई *(Boswellia serrata),* जामुन *(Syzygium cumini),* बबूल *(Acacia auriculiformis)*

5. अम्लीय भूमि (Acidic soil) pH 5.5 से कम

खैर *(Acacia catechu),* नीम *(Azadirachta indica),* करंज *(Pongamia pinnata),* सफेद शिरस *(Albizia procera),* शीशम *(Dalbergia sissoo),* बबूल *(Acacia auriculiformis),* ऑवला *(Emblica officinalis)*

The Prospect of Bio-fertilizers for Sustainable Plant Development

Rupnarayan Sett

Genetics & Plant Propagation Division, Tropical Forest Research Institute, Jabalpur

Agro-ecosystem is defined as a collection of agronomic crops and animals considered in the context of the biological, physical, social and economic environment. Bio-fertilizers act as renewable inputs helping in better crop nutrient management and maintenance of soil health; different bio-fertilizers including the role of VAM in plant growth is described henceforth.

To increase the agricultural output, agro-ecosystem integrated management is efficiently practiced; the integrated management of such a system can lead to establishing better performance. The paramount issues in agricultural production consist not only of yields per land unit but of qualities of food and fiber that can be produced and delivered per hectare of land, unit of energy and human time expended. The increase in crop production and land productivity in India is one of the essential steps to meet the food demand of the growing human population. With no possibility of stretching the land resources, increased agricultural production has to come through the adoption of better management technology. Increasing dry land farming and development technologies for arid lands with soil related constraints now acquire a new importance and emerges as a new frontier for agricultural development. Long term sustainability in agriculture is possible through:

- The use of low cost farm grown inputs which work in harmony with nature. Bio-fertilizers act as perpetually renewable inputs helping in better crop nutrient management and maintenance of soil health.
- Better soil and water management.
- By adoption of improved agricultural practices.

Trees and other plants survive on essential nutrients like nitrogen, phosphorus, potassium and several minerals they receive from soil and carbon source provided to them by photosynthesis. In agriculture, chemical fertilizers have been widely used, but their requirements have gone up substantially per plant because of the inefficient uptake by the plants resulting from their leaching away from soil, and reduced uptake by plants grown on soil from which microelements catalyzing the uptake of these fertilizers by plant have been depleted due to intensive crop production, thus resulting in the use of chemical fertilizers becoming a very costly affair.

Many a microbial inoculants have been developed for improved supply of nitrogen, phosphorus and trace elements to the plants for significant development. Application of bio-fertilizers as a major alternative tends to minimize the ecological disturbance. Most of the bio-fertilizers are formed by microbes like algae and fungi. They, so often portrayed as the simplest and humblest vestiges of life, are in fact the most versatile and talented, products of evolution. Stem-nodulating legumes such as *Sesbania rostreta* and incorporating *Azolla,* blue green algae and other sources of symbiotic and non-symbiotic nitrogen fixation in the farming system are fundamental to sustainable agriculture. The only disadvantage of the organic supplements is that they are required in bulk and they cannot be transported over distances. But this argument can be answered by the fact that most of these bulky organic supplements can be generated at the farm itself. The nutrient rich composts and bio-fertilizers also help in substituting market purchased inputs, and thus are economically attractive for the farming families.

Some of the important groups of bio-fertilizers are detailed below.

***Azolla-Anabaena* symbiosis**

Azolla is the globally distributed small aquatic fern comprising of 7 living species. In their leaves a heterocystous di-nitrogen-fixing blue green alga *Anabaena azollae* is always present as symbiont. *Azolla* is an alternative N source. The agronomic potential of *Azolla* as bio-fertilizer for rice has been recognized in many countries including India, Philippines, USA, Sri Lanka and Thailand. A trial under International Network on Soil fertility and Fertilizer Evaluation for Rice (INSFER) conducted at 37 sites in 10 countries also confirmed the bio-fertilizer potential of *Azolla*. *Azolla* when grown in fallow rice fields increased its fresh weight by 2-6 folds in a week and produced 330 tons fresh biomass ha^{-1} which was equivalent to 840 kg N.

Nitrogen-fixing bacteria *Rhizobium*

Symbiotic N_2 - fixation by *Rhizobium* with legumes contributes substantially to total biological nitrogen fixation (BNF). *Rhizobium* inoculation is a well known agronomic practice to ensure adequate nitrogen nutrition of legumes in place of fertilizer nitrogen. The three Rhizobial genera include *Rhizobium, Bradyrhizobium* and *Azorhizobium.* Root infection by Rhizobia is a multistep process initiated by pre-infection events in the rhizosphere. Various events which lead to the formation of nodules include mutual recognition of host plant and *Rhizobium* species, rhizobial adherence to the root hairs, root hair curling, root hair infection, division of cortical cell to form root primordia and finally formation of nitrogen-fixing tissues in the nodules. In the formation of nodules, several bacterial and plant genes are involved and structure, function and regulation of several such genes are now

known. Various bacterial genes involved in symbiosis are *nod, nif* and *fix* genes. Several plant genes, specifically induced in root tissues as a consequence of the interaction with Rhizobia, are known as nodulin genes. Rhizobia can infect wheat, rice, maize and oil seed rape forming nodule-like structures. The slow growing rhizobia are grouped under the genus *Bradyrhizobium* and the fast growing under the genus *Rhizobium.*

The ability to fix high amount of N (efficiency) is governed by the symbiotic capability between *Rhizobium* and the host plant. It may be necessary to introduce superior strains of *Rhizobium* to ensure adequate N_2 fixation for maximum growth and yields of the host plant. The performance of inoculation is variable. In pigeon-pea, significant increase in early nodulation due to inoculation was not always well correlated with the final grain yields. Increase in grain yield of the pigeon-pea ranged from 19 to 68% over un-inoculated controls.

Diazotrophs

Diazotrophs which comprise a large group of aerobic chemolithotrophs (*Thipobacillus, Desulphovibrio*), anaerobic photoautotrophs (members of Rhodospirillaceae, Chromatiaceae and Chlorobiaceae), aerobic to micro-aerobic heterotrophs (members of Azotobacteraceae and Bacillaceae), Corynebacteriaceae (*Azotobacter*) and Spirillaceae (*Azospirillum*) are the free-living as well as associative form which fix nitrogen in the rhizosphere of a variety of crop species. Diazotrophs like *Herbaspirillum* spp. grow endophytically in the stems and leaves of sugarcane and rice. *Azoarcus* inhibits roots of Kallar grass (*Leptochloa fusca*) and rice. Although many genera of bacteria are isolated from the rhizosphere of various cereals, many members of *Azotobacter* and *Azospirillum* genera have been widely tested to increase yields of cereals under field conditions. Many experiments have been performed in several countries to investigate the effect of inoculation of various strains of *Azotobacter chroococcum* and *Azospirillum* spp. on cereals and grasses. *Azotobacter* is effective only in soil with a native *Azotobacter* population. *Azospirillum* are the other useful inoculants. It is widespread in distribution and easy to culture and identify. In Israel, field experiments with *Azospirillum* were carried out using different cereal crops. Multi-location trials in India showed that seed inoculation with *A. brasilense* increased the mean grain yield of pearl millet significantly at 6 out of 9 locations tested.

Frankia

Frankia is a member of Actinomycetes or ray fungi. It forms nodules with higher plants like *Alnus* and *Elder*. There is a need to determine the defence response of a crop to *Frankia* and technologies to engineer the plant to nodule with *Frankia*. It produces true mycelium and the spores are not produced.

Cynobacteria

Species of *Anabaena, Nostoc, Scytonema, Calothrix, Aulosira, Nodularia, Lyngbya* and *Mastigocladus* etc. are able to fix nitrogen. Most of the crops which grow in plenty of water like rice etc. have association of these blue green algae or Cynobacteria. It is a common observation that if a soil is under rice cultivation there is native cynobacterial flora and may not need fresh inoculation. If crops are changed as in most parts of the country, there is need to use fresh inoculums. Usually a mixture of these algae is used and not monoculture. The cynobacterial flakes are mixed at the rate of 10^{15}kg ha^{-1} one week plantation.

Phosphate solubilizing bacteria

A large number of heterotrophic and autotrophic soil micro-organisms are now known to have the capacity to solubilize inorganic phosphates through their metabolic activities directly or indirectly. The solubilization of different types of insoluble phosphate varies with the type of microorganism, the type of phosphate available and available carbon source. Rhizosphere soil of wheat possesses a greater number of phosphate solubilizing bacteria than in the non-rhizosphere soil. *Bacillus* spp., *Pseudomonas* sp., *Brevibacterium* sp., *Acrobacter acrogens*, *Serretia* spp., *Nitrobacter* and *Escherichia freundii* are important phosphate solubilizing and phosphate mobilizing microbes. Phosphatic bio-fertilizer was first prepared by the Russian scientists using *Bacillus megaterium* var. *phosphaticum* as phosphate solubilizing bacteria and the product was termed as 'Phosphobacterin'.

Phosphate solubilizing fungi

Along with bacteria and actinomycetes certain fungi also solubilize phosphate. *Aspergillus awamori* has been found to be better solubilizer than *Bacillus polymyxa* or *Pseudomonas striata*. Phosphate solubilizing bacteria *Pseudomonas* and fungi *Aspergillus* are found in the rhizosphere of coconut and cocoa.

Plant growth promoting Rhizobacteria

Several strains in *Bacillus* have been patented for commercial production in developed countries. The plant growth promoters belonging to pseudomonads and bacilli play a major role in plant productivity. These are usually non-colonizers. The spore forming bacteria are promising organisms for microbial control. *Pseudomonas fluorescens* is registered as microbial pesticide against *Phythium* and *Rhizoctonia.*

Mycorrhiza for sustainable agriculture

The root fungus symbiosis is caused by mycorrhizae. The association of mycorrhiza is wide-spread in bryophytes, a large number of pteridophytes, most or all species of gymnosperms and some 90 per cent or more of angiosperms. The association of fungus and roots of higher plants is termed as 'mycorrhiza'. Forest crops may have

ectomycorrhizae while endomycorrhizae are present in most agricultural crops. These mycorrhizae differ in their structure and in the systematic position of the fungi involved. There are 8 distinctive types of *Eucalyptus* ectomycorrhizas. Tropical ectomycorrhizas are synthesized on *Pinus ponderosa* by four fungi species, viz., *Amanita muscaria*, *A. pantherina*, *Suillus granulatus* and *Lactarius deliciosus*. *Russula aeruginea* is another fungus forming ectomycorrhiza in *Picea*. Ectomycorrhizal fungi grow best at pH 5-6. Excess of inorganic fertilizers suppress ectomycorrhizal development. It has been found that optimal development of ectomycorrhiza in Chir Pine nurseries occur when nutrients are present in the soil at half the normal level. Shading suppresses ectomycorrhizal development. The poor development of mycorrhizal root results in the stunted growth and chlorosis of leaves. The mycorrhizal plants are able to withstand better water stress condition than the non-mycorrhizal seedlings. The mycorrhizae are described as 'Biofertilizer' and 'Biocide'. The multilayered mantle formed by *Pisolithus tinctorius* which envelops the entire root is typical ectomycorrhizae. The mantle of *P. bicolor* consists of sparse hyphae embedded in a considerable amount of mucilage, similar to ectomycorrhizae formed by *Wilcoxina* species on Pine. Arbutoid mycorrhizae (*P. tinctorius – Arbutus mycorrhizae* or association of ectomycorrhizae with *Arbutus*) may be a modified type of ectomycorrhiza, with structural difference determined largely by the host reaction to colonization by typical ectomycorrhizal fungi. The ectomycorrhizal association produces minor changes in the root morphology. The mantle surrounding the root is absent. There are two mycelial networks, one on outer side and one internal. The orchids have endomycorrhiza which is called Glomerate-endomycorrhizal association of a different type. Ectendo-mycorrhizae are characterized by presence of a mantle and mycelium penetrating the root cells.

VAM: Vital for soil management

Vesicular arbuscular mycorrhizal (VAM) fungi are ubiquitous soil microbes and are found associated with crop plants, forest plants and other plants. These fungi are not host specific but differ in their characteristic association with host rhizosphere. VAM has been reported from 1000 genera of plants representing some 200 families. Pinaceae, Orchidaceae and Caesalpiniaceae do not have VAM. Vamycorrhizae are formed by non-separate zygomycetous fungi belonging to the genera *Glomus, Gigaspora, Acaulospora, Enterophospora*, *Sclerocystis* and *Scutellospore*. The fungi being obligate biotrophs, do not grow on synthetic media and hence are classified according to the morphological characteristics of the spores formed in the soil. Spores are present in dormant stage in soil. Surface wall layer spores seen under scanning electron

microscope may help to identify a species. Endomychorriza has been considered as biological enigma.

- Ecology of VAM: The distribution and occurrence of VAM differ both qualitatively as well as quantitatively with the change in edaphic factors and the type of vegetation. The pH of soil plays an important role; same pH may not be equally good for all. The number of spores in soil is also influenced by the season. Maximum number of spores is encountered during July-October. The number of VAM spore also varies with depth of soil and altitude.

- VAM multiplication: VAM fungi may produce zygospore, azygospore or chlamydospore. Most VAM fungi sporulate outside the plant roots in soil. However, there are 10 species of *Glomus* which possibly sporulate in root.

Soil inoculum is produced in traditional "Pot-Culture". Rhodes grass was found to be the best host. *Sphagnum* moss peat and nutrient film technique channels can be used for VAM culture. Large scale inoculum can be produced by aeroponics or tissue culture of root also. Expanded clay aggregates have been used for mass multiplying VAM fungi in Germany. Axenic culture of VAM (*Glomus aggregatum*) associated with *Cymbopogon martini* var. *motia*) has also been tried.

- VAM in agriculture and forestry: The effect of VAM on plant growth and yield has been extensively studied in relation to economically important plants like rice, jowar, pearl millet, soybean, groundnut barley, sunflower and ginger. A combination of legumes, rhizobia and mycorrhizal fungus brings a significant improvement in plant growth through increased availability of phosphorus together with nitrogen fixation in soil. Nitrogen fixing microbes interact with VAM fungi producing synergistic effects. The combination may prove the cheapest way to enrich tropical soil with nitrogen. Indigenous VAM stimulated growth in mung, green gram (*Phaseoulus aureus)* and Urad bean in pot culture. Mycorrhizal fungi in agroforestry has been found useful for *Acacia nilotica, Prosopis cineraria, Proposis juliflora*, *Acacia famensiana*, tissue culture raised plants of edible bamboo (*Dendrocalamus*).

- Improved productivity in medicinal plants: Plant can serve as factories for the production of vital medicinal compounds. The effect of 3 *Glomus* isolates on neem seedlings has been reported. Organics amendment with *Calotropis* has been found useful for *Glomus fasciculatum* in improving the yields of alkaloid in *Catharanthus roseus.*

- VAM as disease-control agent: *Fusarium* disease severity in *Albizia procera* and *Dalbergia sissoo* was significantly reduced when inoculated with mycorrhizal fungi. VAM

formed by *Gigaspora* exerted an inhibitory effect on the development of pigeon pea blight caused by *Phytophthora drechsleri f. sp. cajani.* The addition of *G. fasciculatum* together with the pathogen *S. rolfsii* nullified the effect of the pathogen in peanut. Yields of two varieties of gram in the presence of fungicide metalyxyl increased when *Glomus* spp. were present. *Glomus lates* reduced the percentage of *Fusarium* infection in tomato and Capsicum roots at different rates. Not only fungi but some viruses too are known to be inhibited by VAM fungi.

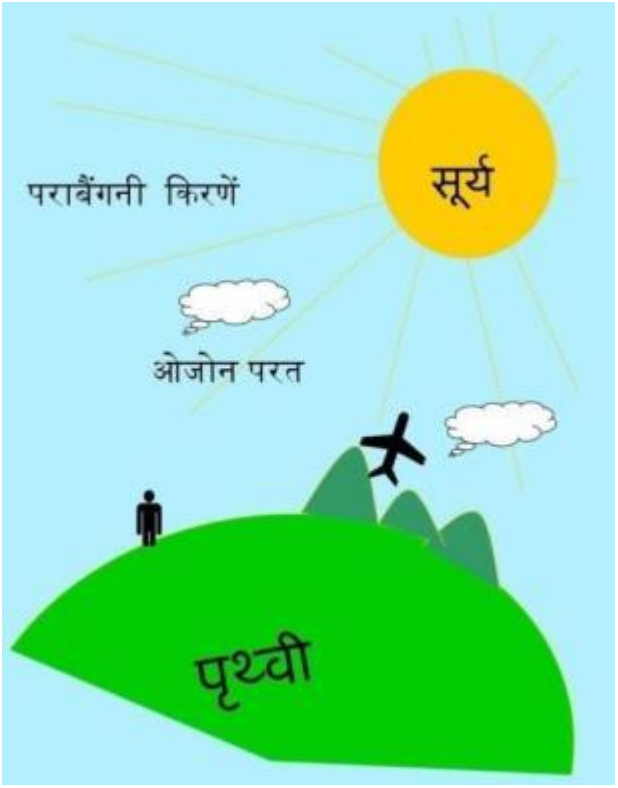
पराबैंगनी विकिरण, ओजोन परत और हमारा पर्यावरण

डॉ. राजेश कुमार मिश्रा, डॉ. नसीर मोहम्मद एवं ट्रीसा हेमल्टन

संगणक एवं सूचना प्रौद्योगिकी अनुभाग/आनुवांशिकी एवं पादप प्रजनन प्रभाग
उष्णकटिबंधीय वन अनुसंधान संस्थान, जबलपुर

पिछले कुछ दशकों से पराबैंगनी विकिरण में हो रही वृद्धी का पर्यावरण पर अत्यंत विनाशकारी प्रभाव पड़ रहा है । पूरी दुनिया में उभयचर आबादी (एम्फिबिऑन पॉपुलेशन) बढ़ते पराबैंगनी विकिरण के प्रभाव के कारण नष्ट हो रही है क्योंकि वैज्ञानिकों का ऐसा मानना है कि उभयचर अण्डे पारदर्शी एवं अत्यंत संवेदनशील होते हैं । पराबैंगनी विकिरण बी के बढते स्तर के फलस्वरूप पौधों में प्रकाश संश्लेषण की गतिवविधी में कमी आ रही है । प्रकाश संश्लेषण भोजन चक्र का एक महत्वपूर्ण आंतरिक भाग है जिसके द्वारा पौधे जल और सूर्य के प्रकाश की उपस्थिति में शर्करा का निर्माण कर सकते है । पौधों की इस क्षमता का पतन उनके लिए विनाशकारी साबित हो रहा है । आनुवांशिकी अभियांत्रिकी द्वारा पराबैंगनी विकिरण बी प्रतिरोधी पौधे विकसित करने का दावा किया गया है । परंतु पराबैंगनी विकिरण बी प्रतिरोधी पौधे विकसित होने से वातारण में पारिस्थितिकी असंतुलन होने का खतरा भी हो सकता है ।

पृथ्वी पर जीवन के लिए वायुमंडल में विभिन्न गैसों का संतुलन महत्त्वपूर्ण है। अन्य गैसों के समान ओज़ोन भी जीवन की गतिशीलता में आवश्यक भूमिका निभाती है। ओज़ोन गैस पृथ्वी के वायुमंडल के ऊपरी हिस्से में एक ऐसा आवरण बनाती है जिससे अंतरिक्ष से पृथ्वी की सतह की ओर आने वाला हानिकारक पराबैंगनी विकिरण ऊपरी वायुमंडल में ही रुक जाता है। इस प्रकार धरती के जीव-जंतु हानिकारक पराबैंगनी विकिरण के कुप्रभाव से बचे रहते हैं । लेकिन आज पृथ्वी पर विभिन्न जीवन-सहायक कारकों का संतुलन बिगड़ रहा है और ओज़ोन आवरण भी झीना होता जा रहा है। ओज़ोन आवरण के पतले होने के

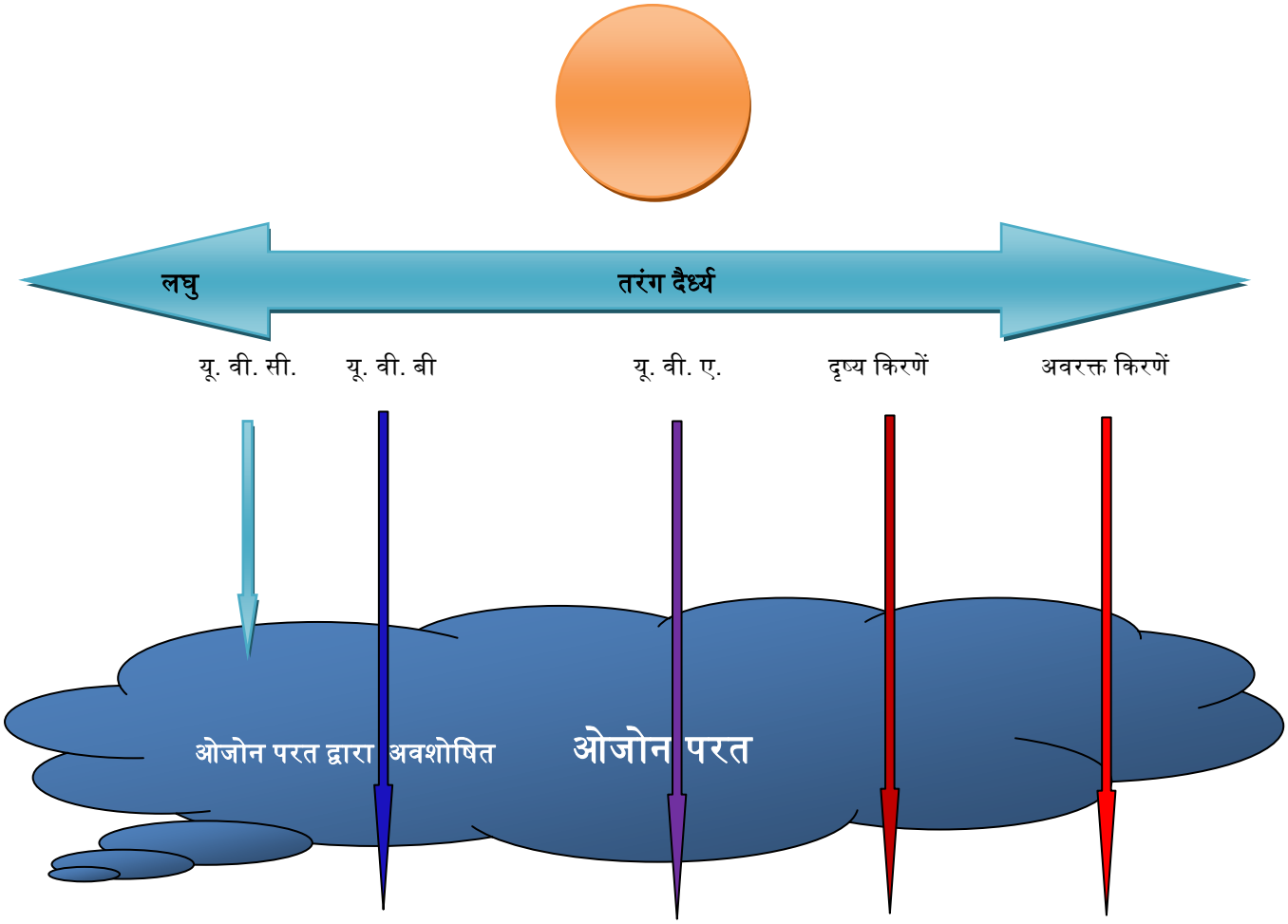


कारण पृथ्वी पर हानिकारक पराबैंगनी विकिरण की अधिक मात्रा पहुंच सकती है। इसके परिणामस्वरूप त्वचा रोग एवं कैंसर जैसी विकृतियों में वृद्धि होने की संभावना है। असल में ओज़ोन आवरण के झीनेपन का सम्बंध वायुमंडल में हाइड्रो क्लोरोफ्लोरो कार्बन व अन्य हानिकारक रसायनों की मात्रा में वृद्धि से है। इन तत्त्वों का रिसाव रेफ्रिजरेटर, एयरकंडीशनर, स्प्रे व कुछ औद्योगिक कार्यों से होता है । जहां एक ओर ओज़ोन गैस ऊपरी वायुमंडल में ओज़ोन आवरण के रूप में जीवन के लिए महत्त्वपूर्ण भूमिका निभाती है वहीं धरती की सतह पर वायुमंडल में इसकी अधिक मात्रा हानिकारक हो सकती है । ऊर्जा एवं संसाधन संस्थान (टेरी) ने देश में बढ़ते ओज़ोन के स्तर के बारे में आगाह किया है । टेरी को 2010 में भारत

के कुछ बड़े शहरों में हवा की गुणवत्ता सम्बंधी आंकड़ों के अध्ययन से ये परिणाम मिले हैं। टेरी ने चिंता जाहिर की है कि यदि 2030 तक ऐसा ही चलता रहा तो ओज़ोन और कण पदार्थ, दोनों ही उच्च स्तर तक पहुंच जाएंगे।

ऐसा माना जाता है कि पृथ्वी के निर्माण के प्रारंभिक दिनों में यहां पर पराबैंगनी किरणों (अल्ट्रा वायलट रे) की बरसात होती थी। इसलिए पृथ्वी पर जीवन असंभव था। उस समय वायुमंडल में आक्सीजन बहुत कम मात्रा में थी।

समय के साथ-साथ आक्सीजन की मात्रा बढ़ती गई और यह अल्ट्रा वायलट किरणें आक्सीजन को ओजोन में बदलने लगी। पृथ्वी के चारों ओर स्थित समतापमंडल (स्ट्रैटोस्फीयर) में अरबों टन ओजोन गैस जमा हो चुकी है। यदि यह न हो तो सूर्य से निकलने वाली पराबैंगनी किरणों से पृथ्वी पर मनुष्य , पशु, पक्षी समाप्त हो सकते हैं। मानवजाति के लिए औद्योगिक क्रांति जहां एक ओर वरदान साबित हुई है, वहीं दूसरी ओर यह उनके विनाश का कारण भी बनी हुई है। ओजोन परत के तेजी से हो रहे क्षरण के फलस्वरूप मानव जीवन के अस्तित्व पर मंडरा रहे खतरे को लेकर पूरा विश्व चिंतित है।



कुछ भाग ओजोन परत द्वारा अवशोषित कुछ सतह पर पहुँचा।

सम्पूर्ण सतह पर पहुँचा।

पराबैंगनी किरणें दृष्टिगोचर प्रकाश में लाल, नारंगी, पीला, हरा, आसमानी, नीला और बैंगनी रंग दिखाई पड़ते हैं। यदि सूर्य की किरणों को किसी त्रिपार्श्व (प्रिज्म) से होकर एक सफेद पर्दे पर पड़ने दिया जाये तो इन सात रंगों की पट्टी पर्दे पर दिखाई पड़ने लगती है। इस पट्टी को वर्णक्रम कहा जाता है। आजकल यह माना जाता है कि सभी वर्णों की किरणें विद्युतबकीय तरंगें हैं। लाल रंग की रश्मियों या विकिरण का तरंगदैर्ध्य लगभग 7,000 ऋरू और बैंगनी रंग की रश्मियों का लगभग 4,000 ऋरू होता है। सूर्य के प्रकाश तथा अन्य प्रकाशस्त्रोतों से ऐसी किरणें भी निकलती हैं जो आँखों से देखी नहीं जा सकती हैं। जिन अदृश्य किरणों का तरंगदैर्ध्य 4,000 ऋरू से कम होता है, उन्हें पराबैंगनी किरणें कहा जाता है। ये किरणें फोटो-प्लेट या फिल्म को प्रभावित करती हैं। इनकी खोज इसी गुण के आधार पर सन् 1801 ई. में जे.डब्ल्यू. रिटर ने की थी। सन् 1862 ई. में जी.जी. स्टोक्स ने इन किरणों के कई गुणों का पता लगाया था। इनका विशेष अध्ययन करनेवाले वैज्ञानिकों में मैस्कार्ट, थियोडोर लाइमन और रौलैंड के नाम मुख्य हैं।

सूर्य के अतिरिक्त विद्युत् आर्क, विद्युत् स्पार्क और विद्युद्विसर्जन से भी पराबैंगनी किरणें निकलती हैं। सूर्य से निकलनेवाली पराबैंगनी रश्मियों को वायुमंडल का ऑक्सीजन गैल शोषित कर लेता है और वे पृथ्वी तक नहीं पहुँच पातीं। शीशा भी इन किरणों को पूर्णत: शोषित कर लेता है, किंतु क्वार्ट्ज़, या स्फटिक 1,850 ऋरू तक की पराबैंगनी किरणों के लिए पारदर्शक होता है। 2,000 ऋरू से 1,800 ऋरू तक की किरणों को निर्वात पराबैंगनी कहते हैं। ये किरणें आँखों तथा शरीर के अन्य कोमल तंतुओं के लिए हानिकारक होती है। बहुत से पदार्थ इन किरणों को सोखकर दृश्य प्रकाश देने लगते हैं। इसी गुण का उपयोग करके प्रतिदीप्ति लैंप बनाए जाते हैं। कीटाणुनाशक होने से चिकित्सा विज्ञान में भी इन किरणों को प्रयोग होता है। ये आँख से नहीं दिखाई देतीं, परंतु स्वस्थ युवा आँखों में हलके नीले रंग की अनुभूति पैदा करती हैं।

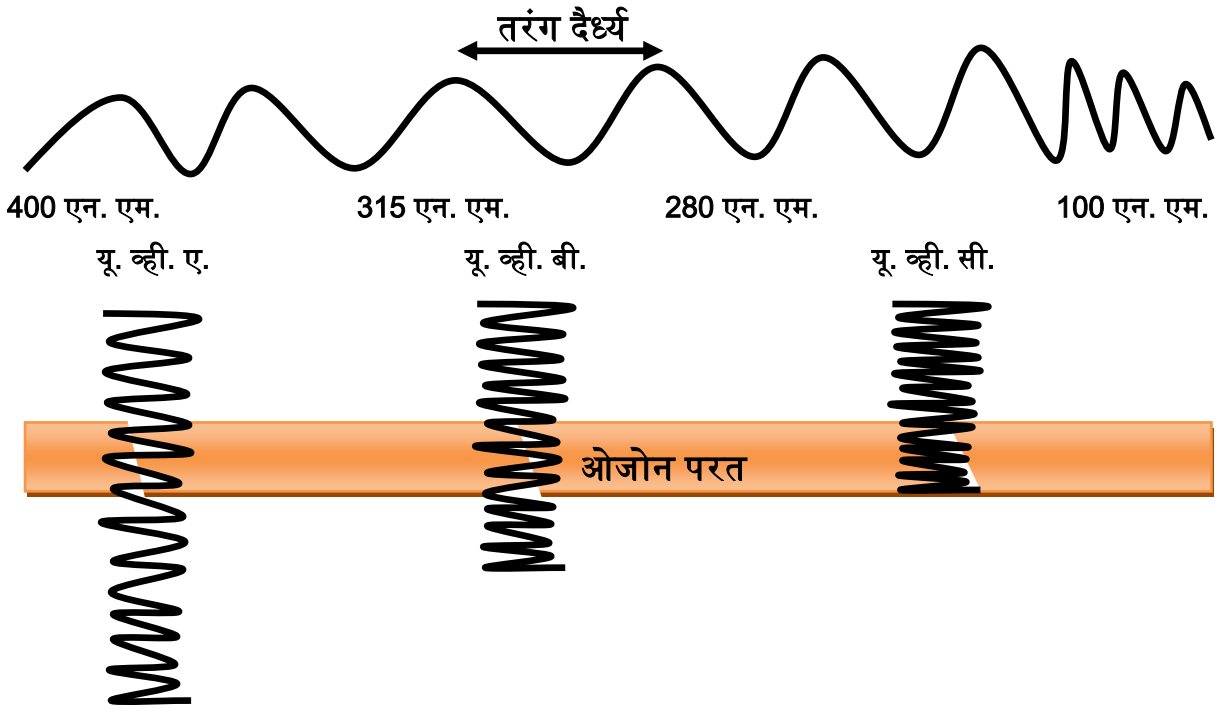
समुद्री जीवन को भी धरती के बढ़ते तापमान और वायुमंडल में बढ़ रहे कार्बन के अलावा पराबैंगनी (यूवी) विकिरण से भी खतरा है। अंतर्राष्ट्रीय शोधकर्ताओं के अनुसार पराबैंगनी विकिरण समुद्री जीवों और पौधों के लिए खतरा पैदा कर रहा है। समुद्री जीवन विशेषज्ञों ने दुनियाभर में समुद्री जीवों पर हुए 1784 प्रयोगों का गहनता से अध्ययन कर पराबैंगनी बी विकिरण (यूवीबी) के हानिकारक प्रभावों की मात्रा का मूल्यांकन किया। विज्ञान पत्रिका 'ग्लोबल इकोलॉजी एंड बायोजियोग्राफी' के अनुसार अभी तक पराबैंगनी विकिरण का समुद्री जीवन पर हानिकारक प्रभावों का अध्ययन नहीं किया गया था। विश्वविद्यालय के बयान के मुताबिक पराबैंगनी विकिरण से सबसे अधिक प्रभावित होने वाले समुद्री जीवों में प्रोटिस्टा (शैवाल), सीप, क्रसटेशियन, मछली के लार्वा और अंडे शामिल हैं। 1970 के दशक से फ्लोरोकार्बन यौगिकों के निरंतर उत्सर्जन के कारण ओजोन परत को नुकसान पहुंच रहा है, जिसके परिणामस्वरूप पराबैंगनी विकिरण का स्तर बढ़ रहा है। यह विशेष रूप से दक्षिणी गोलार्ध में हो रहा है। ओशियंस इंस्टीट्यूट के निदेशक एवं शोध के सह-लेखक प्रोफेसर कार्लोस डूआर्टे ने कहा कि पराबैंगनी विकिरण के बढ़ते प्रभावों का अध्ययन दो प्रमुख भ्रांतियों के कारण सम्भव नहीं हो सका जिनमें एक यह थी कि मांट्रियल प्रोटोकाल ओजोन परत के विषय में है और दूसरा कि पराबैंगनी विकिरण का प्रभाव समुद्र के भीतर नहीं होता।

ओजोन परत के बारे में लोग आम तौर पर भले ही ज्यादा न जानते हों लेकिन यह पृथ्वी और पर्यावरण के लिए एक सुरक्षा कवच की तरह कार्य करती है तथा इसे सूर्य की खतरनाक पराबैंगनी किरणों से बचाती है। 'द एनर्जी एंड रिसोर्सेज इंस्टीट्यूट' के अनुसार ओजोन परत बहुत ही महत्वपूर्ण है जो सूर्य की खतरनाक पराबैंगनी यू. वी. किरणों से हमारी रक्षा करती है। उनके अनुसार बिना ओजोन परत के हम जिंदा नहीं रह सकते क्योंकि इन किरणों के कारण कैंसर, फसलों को नुकसान और समुद्री जीवों को खतरा पैदा हो सकता है और ओजोन परत इन्हीं

पराबैंगनी किरणों से हमारी रक्षा करती है। आस्ट्रेलिया का उदाहरण हमारे सामने हैं , जहां ओजोन परत को काफी नुकसान पहुंचा है । इसी नुकसान की वजह से सूर्य की पराबैंगनी किरणों से बड़ी संख्या में वहां लोग त्वचा के कैंसर का शिकार हुए हैं । एक अन्य खतरा इसके कारण ध्रुवों के पिघलने का है। अंटार्कटिका में ओजोन में एक बड़ा छेद हो गया है। अंटार्कटिका क्षेत्र में बड़े हिमखंड हैं। यदि ये हिमखंड पिघलते हैं तो तटीय क्षेत्रों में बाढ़ सहित कई खतरे पैदा हो सकते हैं। इसके अलावा गर्मी भी बढ़ेगी जो नुकसानदायी होगी । ओजोन परत के क्षरण के लिए क्लोरीन और ब्रोमीन के अणु जिम्मेदार हैं। जब इन अणुओं से युक्त गैसे पर्यावरण में छोड़ी जाती हैं तो ये कालांतर में ओजोन परत के क्षरण का कारण बनती हैं। ओजोन परत को नुकसान पहुंचाने वाली सबसे आम हैलोजन गैस क्लोरोफ्लोरो कार्बन है जिसे सी.एफ.सी. के नाम से भी जाना जाता है। इसे बचाने के लिए सबसे पहले तो जरूरी है कि लोग ओजोन परत और इसके संरक्षण को लेकर जागरूक हों । सभी लोगों को उन पदार्थों और उनके नुकसान को लेकर जागरूक रहना चाहिए जो इस परत को नुकसान पहुंचाते हैं। कई आसान तरीके हैं जिन्हें अपनाकर ओजोन परत को बचाया जा सकता है जैसे पर्यावरण मित्र उत्पादों का इस्तेमाल करना, एयरोसोल और अन्य सीएफसी से युक्त चीजों के उपयोग से बचना, पौधारोपण को बढ़ावा देना, यदि फ़्रीजर और वातानुकूलक काम नहीं कर रहा तो उसे ठीक करवाना आदि । इस तरह की कई छोटी छोटी बाते हैं जिनका ध्यान रखकर ओजोन परत को बचाने में योगदान दिया जा सकता है । उल्लेखनीय है कि ओजोन परत तकरीबन 97 से 99 प्रतिशत तक पराबैंगनी किरणों का अवशोषण करती है । इसके संरक्षण को बढ़ावा देने के लिए मांट्रियल प्रोटोकॉल के अनुसार 16 सितंबर को ओजोन दिवस के रूप में मनाया जाता है ।

ओजोन एक हल्के नीले रंग की गैस है। यह आक्सीजन के तीन परमाणुओं का यौगिक है। वातावरण के ऊपरी भाग में सूर्य की उच्च घनत्व वाली पराबैंगनी किरणों से क्रिया करके आक्सीजन के तीनों परमाणु एक साथ जुड़ जाते हैं। यह गैस एटमॉस्फियर, ट्रोपोस्फियर एवं स्ट्रैटोस्फियर में एक समान रूप में पायी जाती है। ओजोन परत जमीन से 10 किलोमीटर से 50 किलोमीटर की ऊंचाई के बीच स्ट्रैटोस्फीयर में पायी जाती है। इस ऊंचाई पर वायु में ओजोन का अनुपात पृथ्वी के वातावरण में पाये गए अनुपात से अधिक होता है । यह गैस सूर्य की पराबैंगनी-विकिरणों के लिए एक अच्छे फिल्टर का काम करती है। सूर्य की किरणों के अदृश्य भाग में अत्यधिक ऊर्जा वाली पराबैंगनी-सी (220-280 नैनोमीटर), पराबैंगनी-बी (280-320 नैनोमीटर) तथा पराबैंगनी- ए (320-400 नैनोमीटर) किरणें होती हैं । पराबैंगनी बी और सी जीवन के लिए खतरनाक है । स्ट्रैटोस्फीयर में स्थित ओजोन परत पराबैंगनी-सी का अधिकांश भाग रोक देती है और केवल 2-3 प्रतिशत भाग पृथ्वी की सतह तक पहुंच पाता है ।

ओजोन परत में अगर कोई क्षति पहुंचती है तो पृथ्वी की सतह पर पराबैंगनी बी और सी की अधिक किरणें पहुंचेगी, जिसके परिणाम भयंकर होंगे। वैज्ञानिकों का कहना है कि ओजोन परत के नष्ट होने से सूर्य से आने वाली पराबैंगनी किरणों की बढती मात्रा के कारण धरती वीरान और बंजर हो सकती है। यह विकिरण वर्षा , वृक्ष-वनस्पतियों से लेकर जीव-जन्तुओं तक को समान रूप से हानि पहुंचाती है। मनुष्य में इससे आंख की बीमारियां व कैंसर जैसे असाध्य रोग से लेकर अंधेपन तक की स्थिति आ सकती है। इसके सीधे संपर्क में आने से मुनष्यों में त्वचा कैंसर की संभावना बढ सकती है। इस किरण की मारक क्षमता कितनी अपार है, इसका अंदाजा इसी से लग सकता है कि समुद्र तल की वनस्पतियों को भी यह प्रभावित कर सकती है । मौसम वैज्ञानिकों का यहां तक कहना है कि इससे वायुमंडलीय तापमान बढ ज़ाएगा , जिससे बर्फ पिघलने लग जाएगी और समुद्री जलस्तर ब ढ़ने से जल प्रलय जैसी स्थिति उत्पन्न हो सकती है। ओजोन परत अपने आप बनती और बिगड़ती है। यह एक सतत् नियम है। इससे ओजोन का संतुलन बना रहता है।



औद्योगिक युग की शुरूआत के साथ ही ओजोन परत की क्षति की प्रक्रिया भी शुरू हुई। सर्वप्रथम, कैलीफोर्निया विश्वविद्यालय के दो रसायनशास्त्री मारियो मोलाइना तथा रोअरवुड रोलेन्ड ने क्लोरोफ्लोरो कार्बन (सी एफ सी) नामक रसायन की खोज की थी। उन्होंने पता लगाया था कि ओजोन जैसे धरती के रक्षा कवच को सर्वाधिक हानि पहुंचने वाला यही पदार्थ है। परन्तु अमेरिका ने सबसे पहले इस रसायन का प्रयोग एयर कंडीशनरों, रेफ्रीजरेटरों जैसे विलासिता के अत्याधुनिक यंत्रों के निर्माण में किया। बाद में अन्य पश्चिमी देशों-- इंग्लैंड, जर्मनी, फ्रांस ने भी इसका अंधाधुंध प्रयोग करना शुरू कर दिया।

मनुष्य के कुछ क्रिया-कलापों के फलस्वरूप निकलने वाले रसायन ओजोन परत को क्षति पहुंचा रहे हैं। इन रसायनों को ओजोन क्षरण पदार्थ (ओ.डी.एस.) कहते हैं। इनका उपयोग रेफ्रिजरेटरों और प्रशीतन उपकरणों के अतिरिक्त छिड़काव , दाबीकृत प्रसाधनों और स्वास्थ्य उत्पादों, फोम के निर्माण , उद्योगों में सूक्ष्म मार्जन कार्यों और लदान पूर्व प्रक्रियाओं में भी किया जाता है। इसके अतिरिक्त सुपरसोनिक विमान उस ऊंचाई पर उड़ते हैं जो सुरक्षात्मक ओजोन परत को नुकसान पहुंचाते हैं। इंजन के उच्च तापमान के कारण, नाइट्रोजन और आक्सीजन मिलकर नाइट्रिक आक्साइड बनाते हैं , जो ओजोन परत को हानि पहुंचाता है। होमोफ्लुरोकार्बन (हैलोन) रसायन पदार्थ जो आग बुझाने में काम आता है तथा मिथाइल ब्रोमाइड भी ओजोन को नुकसान पहुंचाता है। कार्बन टेट्राक्लोराइड तथा ट्राइक्लोरेथेन दो अन्य रसायन हैं , जिनमें क्लोरीन पाया जाता है , जो काफी हद तक निष्क्रिय अवस्था में स्ट्रैटोस्फीयर में पहुंच जाता है , जहां पर यह ओजोन परत को हानि पहुंचा सकता है।

ओजोन परत बचाने की शुरूआत सर्वप्रथम सन् 1972 में स्टॉकहोम में हुए प्रथम संयुक्त राष्ट्र पर्यावरण सम्मेलन से हुई। इस सम्मेलन में सैकड़ों सुपरसोनिक विमानों द्वारा ओजोन परत को होने वाली क्षति पर ध्यान देने का निर्णय लिया गया। ओजोन परत की क्षति के संबंध में अंतर्राष्ट्रीय स्तर पर पहली कार्यवाही के रूप में वर्ष 1977 में वाशिंगटन में 32 देशों की एक बैठक हुई, जिसमें ओजोन परत की सुरक्षा के लिए एक कार्य योजना को अपनाया गया। अंटार्कटिका के ऊपर स्थित ओजोन परत की भारी क्षति के बारे में जानकारी 1985 के वियना सम्मेलन में दी गई। इस सम्मेलन में निर्णय किया गया था कि विश्व के सब देश ओजोन पर रसायनों का

प्रभाव तथा इसके मनुष्य के स्वास्थ्य एवं पर्यावरण पर पड़ने वाले प्रभाव की सूचना का आदान-प्रदान करेंगे।

ओजोन परत को बचाने की दिशा में सबसे महत्वपूर्ण सम्मेलन कनाडा के शहर मांट्रियल में सितम्बर 1987 में हुआ। इस सम्मेलन में लिए गए निर्णयों में 1990 में विकासशील देशों को आश्वस्त करने के लिए संशोधन किया गया। इसमें निर्णय लिया गया कि ओजोन को नष्ट करने वाली गैसों का प्रयोग बंद कर दिया जाए। यह भी निर्णय लिया गया कि ओजोन को नुकसान पहुंचाने वाली गैसों का उत्पादन और प्रयोग विकासशील देश धीरे-धीरे, परन्तु विकसित देश जल्दी बंद कर दें। इस सम्मेलन में ओजोन के लिए खतरनाक गैसों के स्थान पर दूसरी निरापद गैसों के प्रयोग के लिए विकासशील देशों को आर्थिक सहायता देने की बात कही गई थी। इसके बाद 1992 में डेनमार्क के शहर कोपनहेगन में हुए एक समझौते में ओजोन को नष्ट करने वाली गैसों को जल्दी से जल्दी समाप्त करने की बात कही गई थी।

भारत ने इस समझौते पर 1992 में हस्ताक्षर किये। भारत के दबाव के कारण इसमें एक अनुच्छेद 5 जोड़ा गया था। इस अनुच्छेद के अनुसार ओजोन हानिकारक पदार्थों के प्रति व्यक्ति 300 ग्राम से कम खपत वाले देशों में इन पदार्थों के प्रयोग को बंद करने तथा तकनीकी हस्तांतरण के व्यय को विकसित देशों द्वारा वहन किया जाएगा। भारतीय रिजर्व बैंक ने सभी वित्तीय संस्थाओं और बैंकों को निर्देश जारी कर ओ.डी.एस तकनीक वाले नए उद्योगों को वित्तीय सहायता देने पर रोक लगा दी है। ओडीएस के आयात और निर्यात को नियमित करने के लिए लाइसेंसिंग प्रणाली शुरू की गई। मांट्रियल संधि का पालन सुनिश्चित करने व कानूनी सुविधा प्रदान करने के लिए ओडीएस नियमन एवं नियंत्रण नियम , 2000 भी अधिसूचित किया गया है। इस नियम के अंतर्गत कुछ आवश्यक दवाइयों के उत्पादन को छोड़कर विभिन्न उत्पादों में पहली जनवरी , 2003 के बाद भी सी एफ़ सी के इस्तेमाल पर रोक लगा दी गई थी।

ओजोन परत का छिद्र अंटार्कटिका के ऊपर स्थित है। यह सामान्यतः सितम्बर और अक्तूबर के दौरान बढ़ता है। इन्हीं बातों को ध्यान में रखते हुए संयुक्त राष्ट्र महासभा ने 23 जनवरी 1995 को एक प्रस्ताव पारित किया। इसमें ओजोन की छीजती परत की ओर लोगों का ध्यान आकर्षित करने और इसे सुरक्षित बनाए रखने तथा जन-सहयोग प्राप्त करने के उद्देश्य से 16 सितम्बर को अन्तर्राष्ट्रीय ओजोन दिवस मनाने की घोषणा की गई थी। 16 सितम्बर का दिन इसलिए चुना गया क्योंकि इसी दिन 1987 में ओजोन के छीजने के लिए जिम्मेदार पदार्थों को धीरे-धीरे समाप्त करने वाली मांट्रियल संधि पर हस्ताक्षर किए गए थे। इसी बात को ध्यान में रखते हुए शनिवार 16 सितम्बर, 1995 को विश्व भर में पहला ओजोन दिवस मनाया गया था। परन्तु मात्र ओजोन परत दिवस मनाने से ही इस दिशा में महत्वपूर्ण प्रयास नहीं कहलाए जा सकते हैं । इसके लिए आवश्यकता है विकासशील, विकसित देशों और अंतर्राष्ट्रीय संघों के बीच आपसी तालमेल की , तभी हमें इस कार्य में सफलता प्राप्त हो सकती है।

अनुसंधान परिणामों से यह ज्ञात हुआ है कि वायुमंडल में छोड़े जानेवाले क्लोरीन और ब्रोमीन युक्त रसायन ओजोन परत को नुकसान पहुंचाते हैं। ओजोन परत के क्षरण से सूरज की पराबैंगनी किरणें समताप मंडल को भेदती हुई सीधे धरती पर पहुंच जाती हैं । ये किरणें मनुष्यों के साथ ही पेड़-पौधों और जीव-जंतुओं पर घातक प्रभाव डालती हैं। अनुसंधानों के आधार पर मॉन्ट्रियल समझौते की शर्तो में यह तय किया गया कि इस पर हस्ताक्षर करनेवाले देश ओजोन परत को नुकसान पहुंचानेवाले क्लोरो फ्लोरो कार्बन (सीएफसी), हेलोन और कार्बन टेट्रा क्लोराइड जैसे तत्वों को एक निश्चित अवधि में पूरी तरह खत्म कर देंगे। बाद के अध्ययनों में ओजोन परत के लिए हाइड्रो क्लोरो कार्बन को भी घातक पाये जाने के बाद इसे भी एक तय अवधि में खत्म करना तय हुआ।

मॉन्ट्रियल समझौते को वैश्विक स्तर पर अप्रत्याशित समर्थन मिला है । इससे ओजोन परत को नुकसान पहुंचाने वाले तत्वों यानी ओडीएस (ओजोन डिप्लेटिंग सब्सटांसेस) को खत्म करने में मदद मिली है । ओडीएस ओजोन परत के ऐसे हानिकारक तत्व हैं, जिनका इस्तेमाल उद्योगों, फार्मा क्षेत्र, वातानुकूलन यंत्रों, फोम, अग्निशमन यंत्रों, धातुओं और कपड़ों की सफाई में तथा फसलों में छिड़काव किये जानेवाले कीटनाशकों और जल्द खराब होने वाली निर्यात की जानेवाली वस्तुओं को सुरक्षित रखने के लिए बड़े पैमाने पर किया जाता है । वैश्विक स्तर पर एक जनवरी, 2010 तक सीएफएस, सीटीसी व हेलोन जैसे घातक रसायनों का उत्पादन और इस्तेमाल पूरी तरह खत्म हो गया । इससे न केवल ओजोन परत को बचाने में मदद मिली है, बल्कि इससे वैश्विक जलवायु तंत्र को भी काफी फायदा पहुंचा है ।

वियना और मॉन्ट्रियल समझौते का हिस्सा बनने के बाद से भारत ओजोन परत के संरक्षण से जुड़ी वैश्विक चिंताओं में भागीदारी निभाते हुए ओडीएस की कटौती में अहम भूमिका निभा रहा है । वर्ष 1993 से समझौते से जुड़े सभी पक्षों, उद्योगों और पर्यावरण कार्यकर्ताओं के सक्रिय सहयोग के जरिये भारत में जनवरी, 2010 के बाद से सीएफसी, सीटीसी और हेलोन गैसों का उत्पादन और इस्तेमाल तकरीबन खत्म कर दिया गया है । यद्यपि, फार्मा क्षेत्र में इसके सीमित उपयोग की अनुमति दी गयी है । इसके तहत दमा के मरीजों द्वारा इस्तेमाल किये जानेवाले इन्हेलरों, फेफड़ों से जुड़ी बीमारियों तथा ऐसे ही अन्य श्वसन संबंधी रोगों के इलाज के लिए भी इनके इस्तेमाल की छूट दी गयी है । हालांकि, इसमें इस्तेमाल होनेवाला सीएफसी असर के लिहाज से ज्यादा घातक नहीं है । भारत में मॉन्ट्रियल समझौते की व्यवस्थाओं की बाध्यता के 17 महीने पहले ही एक अगस्त, 2008 से सीएफसी के उत्पादन पर रोक लगा दी गयी थी । दवा क्षेत्र में इस्तेमाल किया जानेवाला सीएफसी एक विशेष श्रेणी का है । वर्ष 2010 में देश में इस श्रेणी के 343.6 मेगाटन सीएफसी के उत्पादन की अनुमति ली गयी ।देश में दमा रोगियों के लिए अब ऐसे इन्हेलर भी बनाये जा रहे हैं, जिनमें सीएफसी का इस्तेमाल नहीं हो रहा है ।

ओडीएस एक तरह की ग्रीन हाउस गैसें हैं, जिन पर प्रतिबंध के बारे में क्योटो समझौते में कोई व्यवस्था नहीं की गयी थी । अनुमान के मुताबिक, जनवरी, 2010 तक वैश्विक स्तर पर ग्रीन हाउस गैसों के उत्सर्जन में 11 गीगा टन तक की कमी आयी है । यह कमी ओडीएस में कटौती की वजह से हुई है । सीएफसी, सीटीसी और हेलोन जैसे ओडीएस को खत्म करने की दिशा में मॉन्ट्रियल समझौते की सफलता को देखते हुए सितंबर, 2007 में समझौते से जुड़े पक्षों की 19वीं बैठक में अगले 10 वर्ष के अंदर एचसीएफसी गैसों को भी खत्म करने का फैसला लिया गया । विकासशील देशों के लिए इसकी सीमा क्रमश: वर्ष 2009 और 2010 में उत्पादन और इस्तेमाल के औसत के आधार पर तय की गयी है । हमारे देश में एचसीएफसी गैसों का उत्पादन और इस्तेमाल जनवरी, 2013 तक घट कर पहले चरण की सीमा पर आ चुका है.

ओजोन परत में हो रहे क्षरण को रोकने के लिए वर्ष 1987 में 24 देशों के प्रतिनिधियों ने मॉन्ट्रियल में बैठक आयोजित की गई । ओजोन परत क्षरण के कारकों पर मॉन्ट्रियल संधि को इतिहास में सबसे सफल अंतरराष्ट्रीय पर्यावरण संधि के रूप में माना जाता है । वर्तमान में दुनिया के 197 देश मॉन्ट्रियल संधि से जुड़ हुए हैं और ओजोन क्षरण को रोकने के लिए किये गये वैश्विक उपायों में अपनी भूमिका निभा रहे हैं । इस संधि के तमाम सदस्य प्रतिबंधित पदार्थो के उत्पादन और उसके इस्तेमाल के प्रति पूरी तरह से जागरूक और प्रतिबद्ध हैं । वर्ष 1987 में ओजोन परत को नुकसान पहुंचानेवाले 18 लाख टन पदार्थों का उत्पादन होता था, जबकि संधि के 23 वर्ष बाद 2010 तक इसका उत्पादन घट कर 45,000 टन तक आ गया था । इसे संधि की बड़ी उपलब्धि कहा जा सकता है । विभिन्न देशों की सरकारों के सहयोग के बिना इसके उत्पादन में तकरीबन 98 फीसदी की कमी कर पाना मुमकिन नहीं था । साथ ही, वैश्विक

मौसम परिवर्तन जैसी मौजूदा चुनौती से निबटने में भी इसकी बड़ी भूमिका रही है।

प्रकृति में प्रत्येक कारक का अपना-अपना स्थान निश्चित है जिसके चलते वह लाभकारी और हानिकारक हो सकता है। लेकिन प्रकृति ने मानव को ऐसा दिमाग दिया है जिसके बल पर हानिकारक तत्त्वों को पहचान सकता है और उनका उपयोग सीमित करके उनसे होने वाले नुकसान से निजात पा सकता है। इसलिए आम जनता को ओज़ोन आवरण को बचाने के लिए ऐसे उत्पादों का प्रयोग सीमित करने का प्रयास करना चाहिए जो ओज़ोन गैस के विघटन के लिए ज़िम्मेदार तत्त्वों से बने होते हैं।

Biotechnology for forests

Tresa Hamalton

Genetics & Plant Propagation Division, Tropical Forest Research Institute, Jabalpur

Biotechnology is one of the frontier areas of scientific development in the world today. The definition of '*biotechnology*' as in Article 2 of the UN Convention on Biological Diversity is "*any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use*". Biotechnology is the modification and use of living systems/organisms to develop or make useful products, and it includes everything from the use of improved microorganisms in making food products, to the synthesis of nanopeptides in plants for use in repair of tissues in regenerative medicine.

Biotechnology harnesses cellular and molecular processes to develop technologies and subsequently products that help improve the overall living standards of human beings. Though genetic transformation is involved in most of the biotechnological applications developed, biotechnology is not merely the creation of a transgenic (genetically modified) organism. These applications make use of biochemical methods, microbial techniques and advances in molecular biology, apart from the living system to which it is targeted. The techniques employed are not exhaustive or restricted to the above and innovations are being incorporated from time to time for constructive progress.

Biotechnology finds immense use in improving crop and livestock (along with poultry and fisheries) production. It is being harnessed in various aspects of the livestock industry to produce high yielding animal, for enhanced reproduction, to improve nutritional quality and safety of animal-derived foods and their bio-preservation, for production of enzymes and designer livestock products, in meat authentication and so on. With advances in sequencing farm animal genome, the continuing progress in molecular marker technology, and the use of reproductive biotechnology, windows of research opportunities are being opened to improve and revolutionize the livestock industry.

A wide range of crop biotechnologies are available and used increasingly, especially tissue culture based techniques (such as micropropagation and somatic embryogenesis), mutagenesis, interspecific or intergeneric hybridization, genetic modification, marker-assisted selection (MAS), disease diagnostics and bioprotection, and biofertilization. The use of biotechnology benefits agricultural development through

reduction in breeding programme durations, production of improved varieties by MAS, obtaining plants with desired traits by combining cell and tissue culture with new methods of hybridization, and the production of transgenic crops engineered for resistance to pests, diseases, adverse weather conditions and for better nutritional quality.

Forest biotechnology

Forests and other wooded areas perform key economic and ecological functions. The primary goal of forest tree improvement was to identify and select wild seed sources suitable for planted forests. Few recurrent breeding programmes developed from this, not excluding shortfalls in the long-range stability, funding and continuity of efforts required to sustain any forest planting programme. A few tree-improvement programmes matured into recurrent forest tree breeding programmes (improving the genetic value of the population while maintaining genetic diversity). The biological imperative to balance genetic gain against genetic diversity has not only given rise to forest tree programmes that do not resemble those for crops or livestock, but also to novel solutions.

The techniques used for crops hold good for trees also, yet their uses for forestry species are not without limitations. The forestry sector differs from the crop or livestock sectors in a number of important ways. Forest trees are highly heterozygous long-lived perennials with late sexual maturity and a lengthy regeneration cycle. Most forest tree species have narrow regional adaptation and are largely undomesticated. Forest biotechnology applications are specific to each type of forest. Among the range of biotechnologies used, those for planted forests are quite different from those for naturally regenerated forests, and it depends on the level of management intensity (e.g. intensive, semi-intensive) and the genetic material being used (e.g. wild material, genetically improved trees).

Tree improvement uses biotechnologies like hybridization, clonal propagation, inducing mutations (γ-irradiation, UV treatment), polyploid (with more genetic base) selection, use of molecular markers and transgenic technology (for production of improved varieties). Forest biotechnology applications have historically been developed for the benefit of planted forests. The use of tissue culture based micropropagation, application of biofertilizers and genetic fingerprinting using molecular markers are some of the techniques used for less intensively managed planted forests. Whereas, in planted forests that provide raw materials for industries, techniques involving molecular markers, QTL (quantitative trait locus) analyses, somatic embryogenesis and functional genomics find use.

Though sophisticated techniques like backward and reverse genomics approaches,

whole genome sequencing and gene silencing approaches can also be utilized, low-cost tissue culture based clonal propagules which are disease free, marker assisted breeding and selection, and genetic modification for novel traits are much sought after for the most intensively managed forests.

Genetically Modified (GM) trees

The genetic modification of a tree involves the transfer and stable integration of a gene responsible for expression of an economically important trait into the genome of the tree. The gene being transferred could either be a cisgene (gene isolated from the same species) or, a transgene (foreign gene / gene from another organism). The genetic modification of any organism with a transgene results in the production of a transgenic organism. The transfer of multiple genes, all responsible for the expression of either a single desired trait or for more than one trait, is also possible. Genetic modification also includes the suppression of genes related to undesired or detrimental characters through gene-silencing approaches. Important traits considered for production of GM trees include drought tolerance, lignin content, insect and fungal resistance.

Many countries currently have biosafety regulations for the production and use of GM agricultural crops, including fruit-trees. In India, there are no regulations, specific only to the production and use of GM trees. All Genetically Modified Organisms (GMOs) and products thereof are regulated as per the "Rules for the manufacture, use / import / export and storage of hazardous microorganisms / genetically engineered organisms or cells, 1989" (commonly referred as Rules, 1989) notified by the Ministry of Environment and Forests (MoEF), Government of India under the Environment (Protection) Act (1986). Before a genetically modified crop or tree is released into the environment, field trials with rigorous monitoring need to be carried out. After experimentation under contained conditions such as in the laboratory and greenhouse, Biosafety Research Level I (BRL-I) trials are performed in the field with the approval of RCGM (Review Committee on Genetic Manipulation), which is followed by BRL-II trials with the approval of GEAC (Genetic Engineering Approval Committee).

An application to GEAC for the environmental release of a GM crop will not be considered unless First crop season of confined field trials at the level of BRLI, followed by Second crop season of confined field trials at the level of BRLI or BRLII, and Third crop season of confined field trials at the level of BRLII have been completed. In case of trees with long regeneration cycles, genetic manipulation for production of new traits may turn futile, as it will take longer for completion of field trials for three generations before release into the environment, by

which time the new trait will no longer be considered valuable.

Though most GM trees are being modified for insect resistance, stress tolerance and lignin content are also being experimented. GM Rubber tree for enhancing quality i.e., tapping panel dryness tolerance, is the only GM tree that is undergoing approved field trials in India. For the rubber tree, improvement through conventional breeding is limited by long breeding cycles and high levels of heterozygosity. The GM Rubber trees have better drought resistance and increased environment stress tolerance. The target gene incorporated comes from rubber itself, and so it is not transgenic in its strict sense.

In India, no other GM tree produced has gone up to the point of field trials. Whereas, commercial planting of GM poplar has already been done in China on 300 to 500 ha. Though the nation seems to be lagging behind others in the environmental release of GM trees, requirements like the long term confined field trials cannot be omitted. The wider application of genetic modification is also slowed down by severe limitations on the kinds of traits available, complex intellectual property rights regimes and regulatory issues, and the often negative public perception.

Future perspectives

The area of forest biotechnology is expanding from tools development into more hypothesis-driven knowledge acquisition. It is moving from molecular markers into genomics. Biotechnology tools such as molecular markers and the field of genomics can provide knowledge about naturally regenerated tropical forests and important insights into the nature of the entire tropical forest ecosystems including the relationship between forest trees and the microbial communities with which they interact, and this can influence the strategies employed for managing tropical forests.

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Flowering Plants and Insects

Swaran Lata and Dr. P. B. Meshram

Tropical Forest Research Institute, Jabalpur

Insects are known to be the most successful and diverse animals on earth. Insects are under credited for their beneficial services. Most of the flowering plants and insects are interdependent for mutual benefits and also for survival. They have developed an intimate insect-plant symbiotic relationship to one another and coevolved. Both the insects and plants have undergone many structural and morphological changes that make them dependable to each other. The association is so deep if insects decrease in number plants also shows its effect by lowering its number.

Relationship of Insects and Plants

Plants are directly dependent on insects for reproduction. Plants propagate by asexual i.e without involvement of gametes, or sexual reproduction i.e involvement of gametes. Most higher plants propagate by sexual reproduction which occurs by process known as pollination. In some plant species pollination occur by wind, in few species by birds and in majority of plant species pollination occurs by insects. In this process, pollen grains are transferred from the anther to stigma of flower. Pollination patterns in plants are of two types i.e self pollination and cross pollination. When pollen is transferred from anther to stigma of same flower it is known as self pollination or self marriage. But in most of unisexual flowering plants reproduction occur by transfer of pollen from anther of one flower to stigma of another flower and this phenomenon is known as cross pollination or allogamy. Cross pollination plays important role in genetic diversity by exchange of genetic material between two different plants which helps in improvement of traits. When flowers are once fertilized then the corolla soon drops.

Need of Insects as Pollinators

Visit of insects are of great importance to plants due to various reasons reasons. In many plants stamens and pistils are situated in separate flowers. Sometimes relative position of stamens and pistils in same flower makes them not possible to self fertilization. Certain cases they both mature at different times and these plants are generally dependent on visit of insects for pollination. The plants which are pollinated by insects are known as entomophilous plants.

Flowers as pollen and nectar sources

A flower comprises of four different floral parts i.e calax, corolla, stamens and carpals. Corolla is brightly coloured, scented. Their main function is attraction of insects and other animals for pollination. Stamens consist of filament, anther and connective. Each lobe

of anther consist two chambers known as pollen sac. Each pollen sac contains pollengrains which are needed to growth, development and multiplication of the insects. Honey bees, butterflies, moths, grasshoppers, Ants, beetles etc are major insect which are closely linked with pollination of numerous plant species. Moths are dull in colour and nocturnal in habit they pollinate night blooming flowers. Butterflies pollinate flowers that have strong scent, red or yellow in colour and produce large amount of nectar. Nectar is important component of butterfly's diet. Butterflies pollinate flowers less efficiently than the bees but their role is very useful. Among the all the insect pollinators honey bees are major insect pollinators.

Interaction of palnts and Insects

Since time immemorial we have known that flowers are of great importance to insects. Sweet scent and bright colour of flowers attract the insects towards plant. Lines and circles on the corolla guide them to right spot of honey or nectar. Most of the night blooming flowers do not posses these lines or circles. Irregular flowers are always fertilized by insects. Night flowers are generally white, pale yellow, light brown, flesh coloured and odoriferous.

Tanacetum dolichophyllum

Calotropis procera

Malus pumila

Cosmos bipinnatus

Most of the flowers which open at day are red and which open at evening are white. Flowers are necessary to existence of insects and insects on other hand also necessary to existence of insects. Insects show modification in themselves to obtain nectar and pollen from flowers. Flower in turn also change and adapt to the distinctive forms to the action of insects. Thus there is an interaction of insect upon flowers and of flowers upon insect resulting in gradual modification of both. Most of the time it is seen that plants visited by bees or other insects are more healthy as compared to wind pollination. Most of the insect pollinated plants close flowers or sleep for certain periods but most of the wind pollinated flowers remain open all time. Such phenomenon helps in protection of honey and pollen from robber insects which are not capable to fertilizing them. Some of the flowers which attract flower by their scent them emit their scent at particular times of the day and night. In some species of plants two types of flowers one is larger which are fertilized by insects and others are smaller flowers which are self fertilized. Pollen of the plants which are fertilized by insect are sticky in nature as compared to wind pollinated flowers which is dry in nature.

Bee Pasturage

Bees are the most important plant pollinators. Many plants yield pollen, some yield nectar and others yield both. The plants which provide both pollen and nectar to honeybees are known as Bee Pasturage or Nectar and Pollen plants or Bee Flora. Bees normally avoids visiting poisonous plants whose nectar and pollen contains toxicants. *Dalbergia sissoo, Gmelina arborea, Bombax ceiba, Hibiscus rosa sinensis, Magifera indica, Litchi chiensis, Malus pumila, Calotropis procera, Tanacetum dolichophyllum, Cosmos bipinnatus, Delonix regia, Helianthus annus, Centaurea cyanus, Althea rosea, Ageratum conizoides, Cassia festula, Cassia occidentalis, Butea monosperma, Toona cilliata, Pongaamia pinnata, Acacia nilotica, Albezia lebbeck, Azadirachta indica, Eucalyptus spp* etc are the some of the reported bee pasturage.

Thymus linearis

Momordica dioica

Cassia occidentalis

Butea monosperma

Brassica campestris

Aster flaccidus

Insects and Plant Families

Ranunculaceae, Brassicaceae, Papaveraceae, Malvaceae, Caryophyllaceae, Rutaceae, Papilionaceae, Rosaceae, Cucurbitaceae, Cactaceae, Umbiliferae, Apocynaceae, Asclepiadaceae, Boraginaceae, Convolvulaceae, Solanaceae, Scrophulariaceae, Orobanchaceae, Labiatae, Euphorbiaceae, Moraceae, Orchidaceae and compositae are the families in which pollination occurs mainly by insects. Amaranthaceae, Chenopodiaceae, Polygonaceae, Crassulaceae, Cyperaceae, Gramineae are the families in which pollination occur by the wind. Low pollen production, small inconspicuous flowers, dry pollen, feathery stigma, absence of nectar and scent due to which insects are not attracted to the plants. As a source of honey no other family compares with Papilionaceae. Plant species of this family are most preferred for artificial culture of honey bees. Compositae is the largest family of most of the counteries of the world. This remarkable success is due to perfection in pollination mechanism.

Interaction between insects and flowering plant is needed for survival of both, increasing productivity of crops and improvement of livelihood of people. This is only to the honey bees which are able to harness the major portion of nectar and pollen in the form of honey from plant kingdom which otherwise go waste. Hence insects and plant relationship is very necessary for ecological balance and to fulfil human needs.

Soils of India

Chandralekha Taksande

Forest Ecology and Rehabilitation Division, TFRI

As early as 5000 B.C. the Vedas, Upanishads as well as other ancient Indian documents mention soil as synonymous with land – the mother – supporting and nourishing all life on the earth. To the farmer, soil is that portion of the earth surface which he can plough and grow crops. To the poor man soil forms the major ingredients of the mud walls of his house. To the rich man the same soil is used for making bricks to be used as building materials.

Origin of Soil

Soils are formed as a result of weathering of rocks and minerals. Weathering is the disintegration and decomposition of rocks and minerals by physical and chemical process.

The soil is defined as

- The unconsolidated mineral or organic material in the immediate surface of the Earth that serves as a natural medium for the growth of land plants.
- The uncemented aggregate of mineral grains and decayed organic matter with liquid and/or gas in the pores between the grains.

The soil is characterized by varying types when the unconsolidated mineral or organic matter on the surface has been subjected to and shows effects of formation and environmental factors of climate, macro- and microorganisms acting on parent material over a period of time.

Components of soil

Soil contains 45% mineral matter, 25% water, 5% organic matter and 25% air.

SOIL GROUPS OF INDIA

The major soil groups are black soils, red soils, laterites and lateritic soils and alluvial soils.

Regur Soils

- These soils are black in color and are also known as **black soils**.
- Since, they are ideal for growing cotton, they are also called cotton soils, in addition to their normal nomenclature of regur soil.
- These soils are most typical of the Deccan trap (Basalt) region spread over north-west Deccan plateau and are made up of lava flows.
- They cover the plateaus of Maharashtra, Saurashtra, Malwa and southern Madhya Pradesh and extend eastwards in the south along the Godavari and Krishna Valleys.
- These soils are dark Gray to black color, have high clay content, high swelling and shrinkage plasticity, and deep cracks during summer.
- These soils are calcareous, neutral to slightly alkaline, high CEC, poor in organic matter, nitrogen and phosphorus.

Species found are *Acacia nilotica, Aegle marmelos, Ailanthus excelsa, Albizzia lebbeck, Albizzia procera, Artocarpus integrifolia, Azadirachta indica, Eucalyptus hybrid, L. leucocephala, Mangifera indica, Sesbania grandiflora, Syzygium cummini, Terminalia chebula, Zizyphus jujuba and Pongamia pinnata.*

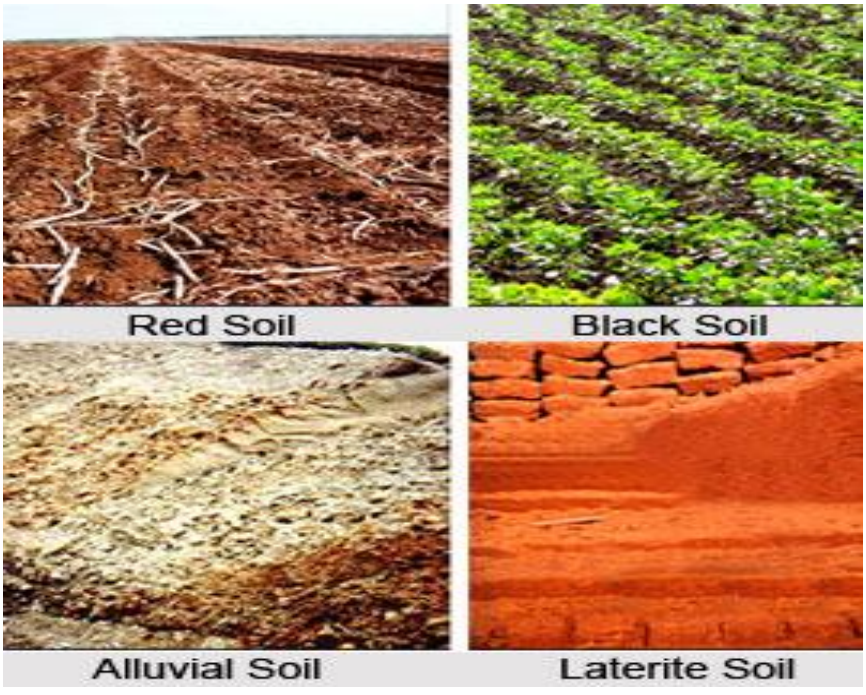
Red Soils

- These soils are developed on old crystalline rocks under moderate to heavy rainfall conditions.
- They are deficient in phosphoric acid, organic matter and nitrogenous material.
- Red soils cover the eastern part of the peninsular region comprising Chhotanagpur plateau, Orissa, eastern Madhya Pradesh, Telangana, the Nilgiris and Tamil Nadu plateau.
- They extended northwards in the west along the Konkan coast of Maharashtra.
- They are red or reddish brown in color, slightly acidic to alkaline, medium CEC, poor in organic matter and mineral and nutrients.

Species found are *Aegle marmelos, Bauhinia spp, Delonix regia, Emblica officinalis, Ailanthus excelsa, Albizzia lebbeck, Albizzia procera, Artocarpus integrifolia, Azadirachta indica, Eucalyptus hybrid, L. Leucocephala, Mangifera indca, Sesbania grandiflora, Syzygium cummini, Terminalia chebula, Terminalia arjuna, Morus alba, Madhuca latifolia and Pongamia pinnata.*

Laterite Soils

- The laterite soils are the result of intense leaching owing to heavy tropical rains.
- They are found along the edge of plateau in the east covering small parts of Tamil Nadu and Orissa, a small part of Chhotanagpur in the north and Meghalaya in the north-east.



- Laterization is a dominant soil forming process and develops on basic rocks.
- They have low pH, poor in nutrients, poor in calcium and magnesium, low CEC.

Species found are *Artocarpus integrifolia, Mangifera indica, Syzygium cumini, Terminalia argjuna.*

Alluvial Soils

- This is the most important and widespread category. It covers 40% of the land area.
- In fact the entire Northern Plains are made up of these soils.
- They have been brought down and deposited by three great Himalayan rivers- Sutlej, Ganga and Brahmaputra- and their tributaries.
- Through a narrow corridor in Rajasthan they extend into the plains of Gujrat They are common in eastern coastal plains and in the deltas of Mahanadi, Godavari, Krishna and Kaveri.

OTHER SOIL GROUPS

- Desert Soil
- Brown Hill Soil
- Tarai or Foot Hill Soil
- Peaty Soil
- Mountain Medow Soil
- Salt Affected Soil

Desert Soils

- The geographical area covered by desesrt soils is 1,54,432 sq km.
- Found in States: Rajasthan, southern part of Haryana and Punjab and northern part of Gujarat.
- The temperature regime is very high throughout the year.
- Built up organic matter status is very low.

- Clay content is very low (2-8%).
- pH ranges from 8.0 - 8.8.

- Soil contains soluble salts but the concentration is not at toxic level.
- Nitrogen content is very low but level of nitrate nitrogen is high.
- Presence of phosphate and nitrate make the desert soil fertile and under moisture supply.

Species found are *Azadirachta indica, Cassia siamea, Acacia tortolis, Acacia nilotica, Prosopis juliflora.*

Tarai Soils

- The soils cover an area of 28,919 sq km in UP, Uttaranchal, Sikkim, Assam, Bihar, Andman and Nicobar and West Bengal
- The soils have wet regime and high water table condition most of the year.

- Soil color is deep black and grey black.
- The texture of soil is sandy loam to silty loam. The soils are fertile and with proper drainage.
- Soils are acidic (pH 4.7-5.8), poor in bases and available plant nutrients.

Species found are *Albizzia procera, Bauhinia spp., Shorea robusta, Pinus roxburghii, Populus deltoides and Dalbergia sissoo* .

Brown Hill Soils

- The geographical area covered is 81,242 sq. km.
- States : UP, Uttaranchal, Himachal Pradesh, Kerala and west Bengal
- Acidic, decrease in pH with the increase of altitude is the trend in north Himalayan forest.
- Soil organic matter, CEC and Nitrogen increase with increasing altitude

Peaty soils

- The soil covers an area of 2,720 sq.km.
- Found in coastal tracks of Orissa, sundarbans of West Bengal, central portion of north Bengal and south east coast of Tamilnadu.
- Occurs in humid region; accumulation of high organic matter.
- Black, clayey and highly acidic.
- Found in basins filled with river deposits interstratified with remains of vegetation giving rise to peat deposits.

Mountain meadow soils

- Covers an area of 59,790 sq.km in Jammu and Kashmir, Himachal Pradesh and Uttaranchal.
- Shallow soils, with grass vegetation occur at high elevation in the Himalaya above the zone tree growth.

Salt affected soil

- Saline or Alkali soils contain excess of neutral soluble salts dominated by chlorides and sulphates.
- Sodic soils contain high exchangeable Sodium percentage.

Nutrient deficiencies

- Availability of micronutrients such as Cu, Zn, Fe, Mn, and B are influenced by soil pH.
- The lower the pH the more soluble and available they are. So in alkaline conditions, plant growth may be limited by deficiencies of these metals.
- Phosphorus is commonly deficient in alkaline soils because it is tied up with Ca or Mg phosphate.
- Only few micronutrients like Mo are more available in alkaline conditions.

Cation exchange capacity: Alkaline soils have higher cation exchange capacity because their high pH stimulates pH dependent charge on the soil colloids.

Calcium accumulation in subsurface layers: Alkaline soils in low rainfall regions commonly have layers of $CaCO_3$, $CaSO_4$ or other such layers that can inhibit plant growth.

Soil water supply: The subsoil layers are always drier than in humid regions resulting in much competition for water by native plants. These soils therefore require greater water management if cultivation is a priority.

Classification of Salt-Affected Soils: This classification is based on Ec, ESP, pH

1. **Saline Soils**

- High dissolved salts in soil solution (affects plant growth)
- EC ≥ 4 dS/m (saturated)
- Exch. Na < 15%
- pH < 8.5

2. **Saline-Sodic Soils**

- Same as saline soils except Exch. Na > 15%

Management of salt affected soil (land reclamation)

1. Saline soils: Establish drainage; Leach with water.

2. Saline-sodic soils: Add Ca (usually gypsum-$CaSO_4$) to remove exchangeable Na; Leach with high quality water to remove excess salts; Leach with high Ca irrigation water.

3. Sodic soils: Add gypsums; Deep tillage; Leach with high quality water when possible.

Characteristics of Alkaline Soils

	pH	EC (dS/m)	ESP
Normal soils	6.5-7.2	<4	<15
Acid soils	<6.5	<4	<15
Saline soils	<8.5	**>4**	<15
Sodic soils	**>8.5**	<4	**>15**
Saline-Sodic	<8.5	**>4**	**>15**

Know your Biodiversity

Swaran Lata and Dr. P. K. Khatri

Tropical Forest Research Institute, Jabalpur

Gyps bengalensis

Gyps bengalensis is a critically endangered species in India and adjacent countries, commonly known as Orientale white backed vulture. It has white neck ruff and white patch of fathers on lower back and upper tail from which its common name is derived. It is distributed in India, Bangladesh, Nepal, Bhutan, Myanmar, Pakistan, Thailand, Combodia and Southern Vietnam. By mid 2000 these vultures were found dead in Pakistan, Nepal and throughout India. In India its decline was first first noticed in Keoladeo National Park Rajasthan. It occurs mostly in plains and less frequently in hilly regions. It breeds on tall trees and breeding season is October to March. These are social animals and lives in flocks. It lays only one egg at a time.

Major decline in their number is primarily due to loss of habitats, nesting grounds and feeding on carcasses of animals treated with the veterinary drugs diclofenac. Diclofenac is a veterinary anti-inflammatory drug used to treat domestic livestock which leads to renal failure resulting in visceral gout of *Gyps bengalensis*. Recently another veterinary drug ketoprofen has also been identified to be lethal to the species in India. Now manufacture and distribution of diclofenac is banned in India and adjoining countries. Disease, pesticides, low food availability, predators, hunting, aircraft strikes are secondary causes of their decline. Felling of old and mature trees in urban areas which are nesting and roosting sites also contribute to population decline. Use of organochloride pesticide in agriculture promotes the decline of mother nature's cleaners. Humans are also a threat to vultures because in some parts of India these are used as medicines.

These vultures are included in Schedule 1 of the Wildlife Protection Act 1972. Low reproductive rate and high longevity are also responsible for very slow increase in population. Conservation strategies should be formulated to save the *Gyps bengalensis* and its vanishing habitats. Identification of number and location of the vultures are needed to take suitable action for its conservation. Captive breeding programmes are also initiated to increase the number of individuals. If vultures are not conserved timely, we will lose the associated ecological services forever.

Bombax ceiba

Bombax ceiba, the Indian Red Kapok Tree is one of the most important tree species that has medicinal, economic, ethnic and ecological importance. It is a very large deciduous tree found throughout India. *Bombax malabaricum* is synonym of *Bombax ceiba*. It belongs to family Bombacaceae. It is commonly known as Silk cotton tree, Red silk cotton tree, Semal. In Sanskrit it is known as Salmali. Due to the thorny appearance it is called "Tree of Yama". The plant proved its existence from the time of Mahabharata. It is called as king of the forest due to massive size and showey flowers.

The bright red flowers appear in January to March on the leafless trees and forms the scarlet carpet on ground after dropping. The flowers are very showy, attractive and visible from long distances. It grows sporadically in mixed deciduous forest and often found growing in association with sal. It thrives best in moist tropical climate. Because of its beautiful and attractive flowers, people like to plant it as ornamental plant in the gardens, botanical garden, or as the avenue species but they avoid these trees near their houses. Vulture and bats prefers to live in the Semal tree. In Hindu custom, vulture and bats are considered as symbols of ill-fate; hence people do not like to keep the Semal tree in the vicinity.

All parts of Semal tree are medicinally and economically important. Wood is used for firewood, ply wood, packing case and also in manufacture of matchsticks. Fruits contain fibrous cotton like substance called "kapok". The cotton is used for stuffing pillows and mattresses. Fruits are cooked eaten and pickled. Flowers and roots are used to treat diarrhea, dysentry, gastrointestinal disorders, bladder diseases, gynecological problems, diabetes, impotence in men and wounds. Paste of bark is used to cure skin problems.

Honey bees, squirrels, deer and other mammals feed upon Semal trees floral parts. It is favorite roosting and resting sites for the large birds especially the vultures, eagles and bats. Decline in Semal population is major cause of vulture disappearance in India. It has been exploited heavily for medicinal and commercial purpose due to which the availability of Semal trees is declining sharply. Throughout India this plant is burnt on the occasion of Holi festival as *Holika dahan*, particularly in the states of Rajasthan, Madhya Pradesh and Uttar Pradesh as whole tree or branches of the tree fixed on ground one month before the Holi festival. Every year thousands of trees are burnt on this day. The *Bombax ceiba* is a multipurpose tree which provides food, medicine, fodder, fiber and fuel. Hence formulation of sustainable conservation strategies and awareness among the people about its ecological benefits are needed to save this multipurpose tree.

खो न बैठे उर्वरा शक्ति धरा, इसी बात से डरते हैं।

उपयोग करो केचुंआ खाद तुम, समर्थन इसी का करते हैं।